

## PREFEASIBILITY REPORT

### 1.0 Introduction

Nalgonda district is located at 17.050°N 79.2667°E. Nalgonda district is bounded by Khammam and Krishna districts (Andhra Pradesh) on the East, Hyderabad, R.R. District, Mahaboobnagar districts on the West, Medak and Warangal districts on North and by river Krishna and Guntur (Andhra Pradesh) on the South. Geographical area is 14,24,000 Hectares. River Krishna forms the Southern boundary of district and travels 85 kms along the Southern Mandals. River Musi enters from North West traverses 64 kms before joining river Alair, it then flows 153 km and joins river Krishna.

The South East part of Nalgonda District, along the Krishna belt is rich in high grade limestone, which is the main raw material to cement industry and as such many cement industries in Large and Medium Sector as well as clinker grinding units are operating in that area. Due to abundance of granite many granite cutting and polishing units have been established in Suryapet area and also in the district border nearer to Hyderabad. Because of Nagarjunasagar project and SLBC, agriculture output has increased and has resulted in establishment of raw rice mills and Parboiled rice mills.

Nalgonda has the largest cluster of parboiled rice mills in Telangana. Due to close proximity to state capital many Large and Medium Scale industries have been established in Bibinagar area and also along NH-9 from Pochampally to Narketpally. Plastic industries are mainly located in Suryapet area. Nalgonda District is industrially progressing in Telangana State the cement plants and many sophisticated industries have already been established. Nagarjuna Sagar, a major multipurpose project is located in the District. It has got bright agricultural resources and hence Agro based industries are flourishing. Limestone, Clay and Feldspar are the important mineral resources available in the District. The Bibinagar-Guntur and Secunderabad-Kazipet railway lines are providing transport to the major industrial products in the District. Due to the rich mineral resources there is further scope for the establishing of new industries in the District.

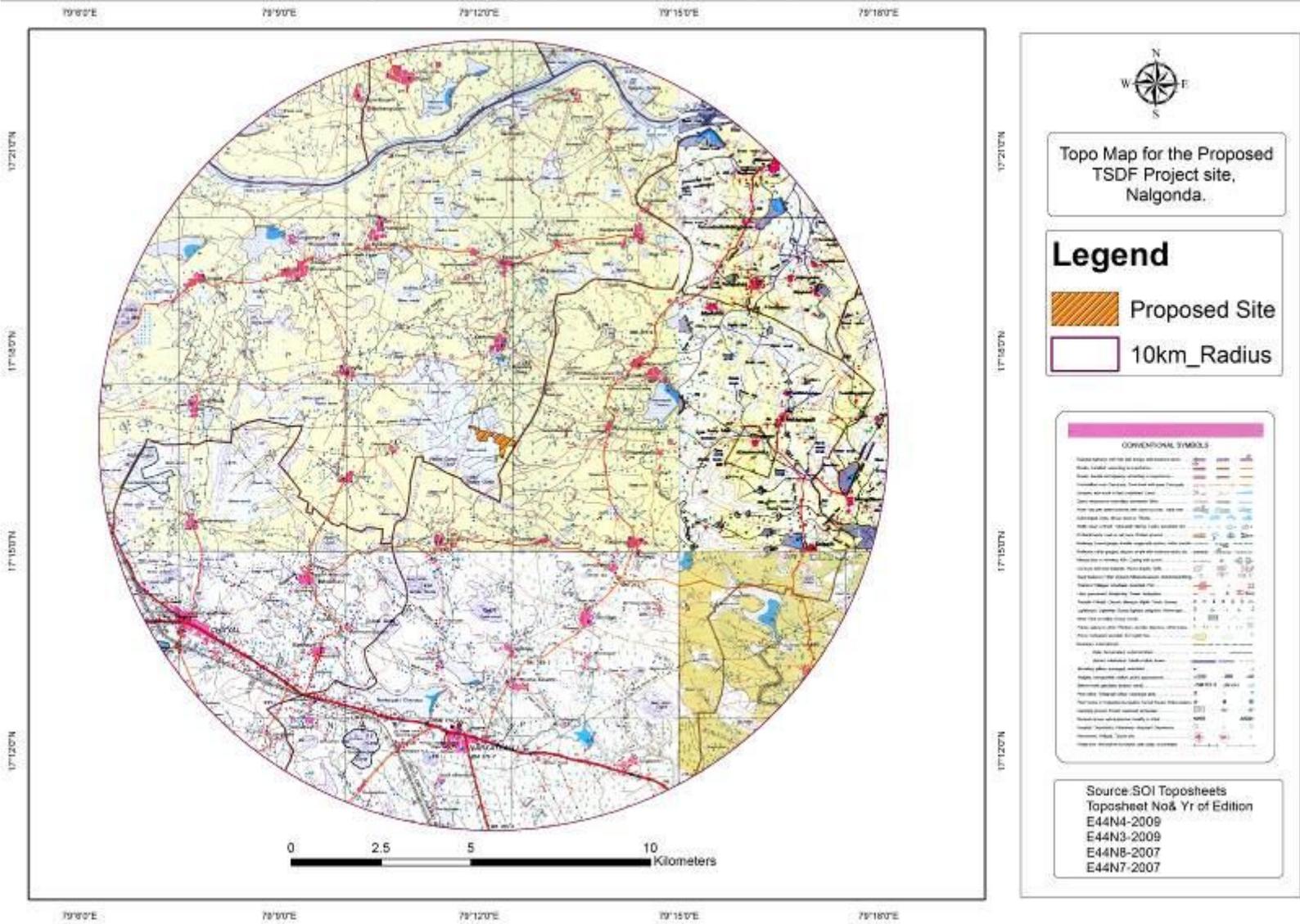
Industrial operations lead to considerable generation of hazardous waste. The major hazardous waste-generating industries in Nalgonda & surrounding districts include Singareni Collieries, Sugars and cements, textile, chemicals, pharmaceuticals, pesticides, paint and dye, Mica, Paper and Pulp manufacturing, inorganic chemicals, power plants, and general engineering industries. Hazardous wastes from the industrial sectors mentioned above contain heavy metals, cyanides, pesticides, complex aromatic compounds (such as PCBs), and other chemicals which are toxic, flammable, reactive, corrosive or have explosive properties affecting the environment.

The location map of the proposed project is given in **Figure 1** & Topographical map given in **Figure 2**.

**Figure 1: Location Map**



**Figure 2: Topographical map of the proposed site (10km)**



Topo Map for the Proposed TSDF Project site, Nalgonda.

**Legend**

-  Proposed Site
-  10km\_Radius

CONVENTIONAL SYMBOLS	
Water bodies (river, lake, pond, etc.)	[Symbol]
Roads (National Highway, State Highway, etc.)	[Symbol]
Railways	[Symbol]
Boundaries (Village, Panchayat, etc.)	[Symbol]
Buildings (Government, Residential, etc.)	[Symbol]
Vegetation (Forest, etc.)	[Symbol]
Contours (Elevation)	[Symbol]
Spot heights	[Symbol]
Grid lines	[Symbol]
Scale	[Symbol]

Source: SOI Toposheets  
 Toposheet No & Yr of Edition  
 E44N4-2009  
 E44N3-2009  
 E44N8-2007  
 E44N7-2007

## 2.0 Summary of the Hazardous Waste

Summary of the hazardous waste generating in Telangana State is given in **Table 1** below

**Table 1**  
**Summary of hazardous waste**

District	Quantity of HW in MTPA		
	Recyclable Waste	Incinerable Waste	Landfillable Waste
Nalgonda	45959.168	20140.472	34117.848
Khammam	2835.915	231.509	46902.06
Mahaboobnagar	6164.868	1424.11	10652.252
Medak	154085.2	37094.143	62492.732
Nizamabad	91.054	72.14	39
Karimnagar	126.876	22.309	31.045
Hyderabad	999.938	615.516	1655.159
Adilabad	143.767	80.04	3171.81
Rangareddy	57541.949	15916.647	62358.842
Warangal	974.628	37.1	4457.025
<b>Total</b>	<b>268923.363</b>	<b>75633.986</b>	<b>225877.773</b>

Hazardous Waste Generating in Telangana [Taken from Centre for Environment and Development, 2014]

## 3.0 Objective of the Project

The primary objective of this project is to provide a facility which will be one stop solution for management of industrial hazardous wastes. The Integrated Common Hazardous Waste Management Facility is being proposed for Recycle / Recovery, Alternate Destruction, Treatment, Storage and Disposal of all kinds of hazardous wastes that are generated in the state of Telangana. The system so designed is reliable for now and for the foreseeable future. The overall objective encompasses the following sub-objectives:

- To ensure that the environmental impacts are minimized.
- To ensure that resource conservation is maximized.
- To ensure techno-economic feasibility of the project
- To enable Hazardous Waste Management Facility to handle the wastes in a lawful manner.
- To prevent accumulation of the wastes at points of generation.

- To establish an administrative framework and recommend the necessary infrastructure to ensure proper collection, transport, recycle, recovery, treatment, storage and disposal of the solid wastes.
- To minimize the health effects associated with solid waste handling and management activities.
- To ensure the technical reliability of the adopted technology in terms of safety, flexibility and sustainability under local conditions.
- To prevent or minimize waste generation.
- To ensure compliance with regulatory requirements at every stage of waste handling.

The outline scope of the proposed project is as mentioned below:

#### Establishment of the facility

- Collection and transportation of solid hazardous waste from generating units
- Fingerprint analysis and interpretation of results in terms of its pathway of recycling / disposal.
- Carrying out Segregation, Recycling / Recovery, Treatment, Storage and Disposal of hazardous waste residues
- Monitoring (on-site) including emergency preparedness
- Reporting to regulatory authorities as needed
- Carrying out Public information and consultation
- Undertaking closure and post closure measures on exhaustion of the site capacity
- Compliance with existing state and central regulations and amendments made from time to time.

## **4.0 Project Proponent**

The proposed project will be established and operated by Telangana Waste Management Project (A division of Mumbai Waste Management Limited) whereas Mumbai Waste Management Limited is a subsidiary of M/s. Ramky Enviro Engineers Limited.

### **4.1 Ramky Group**

#### **4.1.1 Ramky Group Waste Management Division**

Ramky Group's Waste Management Division is the leader in the field of waste management in the country. Ramky has the credit and distinction of having established the first ever bio-medical waste management and hazardous waste management facilities operating on a common platform in India, providing dimension to various other similar projects in the country.

Ramky Waste Management is focused in the fields of Industrial Hazardous Waste Management, Bio-Medical Waste Management and Municipal Solid Waste Management. The group companies have the credit and distinction of having established first-of-its-kind bio-medical waste and hazardous waste management facilities operating on a common platform in the country at Hyderabad. The group today is the leader in waste management in

India, with 16 bio-medical waste management facilities located at Hyderabad, Bangalore, Ludhiana, Ahmadabad, Mumbai, Chennai, Madurai, Salem, Saltora, Kalyani, Haldia, Kolkata, Mangalore and Ghaziabad. Of the above, Hyderabad, Bangalore and Ludhiana are operational for 3.5, 2 & 1 year respectively while the others are nascent. The company, today operating twelve hazardous waste management facilities established and operated under the name of

- Hyderabad Waste Management Project located at Hyderabad (Dundigal)
- Mumbai Waste Management Limited located at Mumbai (Taloja)
- West Bengal Waste Management Limited located at Haldia
- Tamil Nadu Waste Management Limited located at Chennai (Gummidipoondi)
- Uttar Pradesh Waste Management Project located at Kanpur
- Coastal Waste Management Project located at Visakhapatnam
- Rajasthan Waste Management Project located at Udaipur
- Punjab Waste Management Project located at Chandigarh (Nimbua)
- Karnataka Waste Management Project located at Bangalore (Dobaspet)
- Madhya Pradesh Waste Management Project located at Indore (Pithampur)
- Balotra Waste Management Project (Balotra)
- West Bengal Waste Management Limited located at Saltora
- Tamil Nadu Waste Management Limited located at Chennai (Virudhnagar)
- Bihar Waste Management Project ( Bhojpur).

The bio-medical waste management facilities operated is integrated facilities catering to over 3000 health care establishments and over 40,000 inpatient medical services. The facilities comprise of an incinerator, autoclave, shredder, landfill, transport equipment and supporting infrastructure for effective management of bio-medical wastes without any impact to the human health and environment. The company offers high quality un-interrupted services at competitive prices.

The hazardous waste management facilities in operation are integrated facilities catering to over 6000 industrial establishments and catering to over 700,000 TPA of industrial hazardous wastes. The facilities comprise of a secured landfill facility (equivalent to US-EPA, RCRA Subtitle 'C' requirements), a waste stabilization facility, incinerator, intractable and temporary stores, leachate treatment facility, advanced laboratory, transport equipment, administrative and other supporting infrastructure. The facilities have been rated very high by MoEF, CPCB and the State Pollution Control Boards as also by many other national / international visitors. Our facilities are serving as role models for waste management facilities in the country today. Ramky has experience in establishment of waste management facilities with total capacity of over 700,000 TPA of hazardous waste. The company has design, detailed engineering capability for the above-mentioned capacity as proven from the established facilities. All the facilities are equipped with state of the art laboratories capable of performing comprehensive and fingerprinting analysis. The company deploys complete mechanization in collection and transportation of wastes. Ramky's experience in MSW is also exhaustive in terms of various consultancy projects rendered for A.P. and Karnataka States in addition to the MSW management projects awarded at Haldia, Bangalore, Guwahati, Hyderabad and New Delhi.

In a society where environment stands on the top of social agenda with economic policies not tied to the same, our effort towards improvement of environment is seen as a great step towards environmental improvement projects in the country. All the waste management facilities established by the Ramky Group are operated and maintained with high priority towards environment and occupational health and safety aspects. Where possible the operations have been automated or mechanized and all the staff working with the waste are provided with adequate and suitable personnel protective equipment and regular health checkups.

## **5.0 Quantities of Hazardous waste**

The main objective of this project is to develop a feasible Integrated Common Hazardous Waste Management Facility which will cater for the State of Telangana. Hazardous wastes generated will be comprise of the following groups:

ETP sludges, Iron Sludges, Still Bottom residues and process sludges, Spent Carbon, Evaporation salts/ other process salts, Incineration ash, Slags, Asbestos and glass fibers, Spent catalysts and resins, Other hazardous wastes,

Based on the quantities available the following general information could be inferred:

ETP sludges can go directly to landfill either directly or after stabilization.

Still bottom residues, process residues and other organic wastes can be sent for incineration including spent carbon depending on the characteristics of the impurities.

Incineration ash, slags, asbestos and glass fibers are essentially inorganic in nature and can go to landfill directly or with simple stabilization techniques.

Spent catalysts and resins would have to be characterized on a case-by-case basis to assess their nature and characteristics. However, the percentage of wastes generated through these sources is likely to be very small as most of it is taken back by the manufacturers.

Salts will have to be bagged and land filled.

Based on the above compiled information wastes have been classified by their pathway of disposal:

Wastes going to direct landfill, Wastes that require stabilization prior to landfill, Wastes requiring storage until alternate economically viable techniques are made available, Wastes requiring incineration.

## 6.0 Project Details:

Project details and their capacities is given in **Table 2**

**Table 2**  
**Project description and capacities**

<b>1</b>	<b>Name of the Project</b>	<b>Telangana Waste Management Project (A Division of Mumbai Waste Management Limited) at Kakkireni Village, Nalgonda District, Telangana</b>			
<b>2</b>	<b>Promoters</b>	<b>Mumbai Waste Management Limited is a subsidiary of M/s. Ramky Enviro Engineers Limited</b>			
<b>3</b>	Ramky Enviro Engineers Limited Incorporation	<b>Date of Incorporation: 28<sup>th</sup> Nov 1994</b> <b>Commencement of Business: 13<sup>th</sup> Dec 1994</b> <b>Certificate of Incorporation No: 01-18833 1994-95</b> <b>Registration With: Registrar of Companies Andhra Pradesh</b>			
<b>4</b>	<b>Contacts</b>	<b>Ramky Enviro Engineers Limited</b>			
<b>5</b>	<b>Project Site</b>	<b>Survey No. 261, 262, 263, 264, 275, 276, 279 and 280, Kakkireni Village, Ramannapeta Mandal, Nalgonda District, Telangana</b>			
<b>6</b>	<b>Head Office</b>	<b>M/s. Ramky EnviroEngineers Limited Ramky Grandiose, Ramky Towers Complex Gachibowli, Hyderabad – 500032</b>			
<b>7</b>	<b>Contacts</b>	<b>Shri. V.S.Venkatesan</b> <b>(Off): 040 - 23015000</b> <b>(Fax): 040 - 23015100</b> <b>e-mail: <a href="mailto:venkatesan@ramky.com">venkatesan@ramky.com</a></b> <b>Mobile : 09000555198</b>			
<b>8</b>	<b>Business</b>	<b>Integrated Waste Management Facility. Collection, transportation, reception, treatment, storage, re-use, recycle, blending and disposal of industrial hazardous wastes generated in the state of Telangana.</b>			
<b>9</b>	<b>Installed Capacity</b>	<b>Phase</b>	<b>Type of Waste</b>	<b>Units</b>	
		Phase I	Hazardous Waste	Secured landfill	548 TPD
				Treatment/Stabilization	383 TPD
			Bio Medical Waste	50000 @0.25kg/day/bed	12.5 TPD
		Phase II	Recycling Facility	E waste	82 TPD
				Spent Solvent Recycling	27 KLPD
				Used Oil Recycling	54 KLPD
				Used Lead Acid	65 TPD

				Batteries	
				Waste Plastic Recycling	27 TPD
				Waste Paper Recycling	54 TPD
				Alternative Fuel and Raw Material	55 TPD
				Incineration	55 TPD
		Phase III		Renewable Energy	2 MW
				Waste to Energy	2 MW
<b>10</b>	Market	<b>Hazardous Wastes: State of Telangana</b>			
<b>11</b>	Principle of Operation	<b>User-Pay-Principle</b>			
<b>12</b>	Project Cost	<b>Rs.260 Crores</b>			
<b>13</b>	Schedule of Commissioning	<b>Scheduled to commission by Dec 2016</b>			
<b>14</b>	Strengths of the Project	<p>✓ The Facility is located strategically at kakkireni, Nalgonda district which is the hub for present and future growth of industries in Telangana</p> <p>✓ Ramky group of companies has the credit and distinction of being the only experienced indigenous group in Hazardous Waste Management in India. The Ramky group has already established 2 similar projects/ facilities with capacities of 100,000 TPA and 200,000 TPA at Hyderabad for Govt. of Telangana and at Mumbai for MIDC on Build, Own and Operate basis. All the operational data and expertise of the Hyderabad &amp; Mumbai plants will be available to the Integrated Common Hazardous Waste Treatment, Storage and Disposal Facility (ICHWTSDf) project. Also free training of the operational staff will be made available at Hyderabad &amp; Mumbai plants.</p> <p>✓ The Ramky group comprises of managers, engineers, scientists and chemists who are some of the best in the field of waste management to effectively manage and handle the hazardous wastes. Faculty involved in waste management from Ramky have been trained in institutions of repute round the globe like the Waste Management International (WMI) of the U.S.A., the Browning Ferrous Industries (BFI) and Pacific Waste Management of Australia and at SAKAB in Sweden among others.</p> <p>Major aspects that make the Ramky group the technically most competent operator of the Nalgonda Facility include:</p> <ul style="list-style-type: none"> <li>• First hand experience in establishment and operation of the facility.</li> <li>• Nationally reputed and internationally trained faculty in operations and maintenance of TSDFs.</li> <li>• Association with reputed geo-synthetic</li> </ul>			

		<p>manufacturers making the system very reliable and leak proof.</p> <ul style="list-style-type: none"> <li>• Company with high financial capability.</li> <li>• Wide variety of experience in environmental works including water and wastewater treatment, sewage treatment, effluent treatment, bio-medical waste management and hazardous waste management and Recycling.</li> <li>• Wide experience in civil construction and earthworks.</li> </ul> <p>Huge inventory of tools and equipment.</p>
15	Uniqueness of the Project	<p>The Facility will be unique and shall be first of its kind in Nalgonda. It will bridge the yawning gap in the demand and availability of hazardous waste management facilities in the country. In fact it will be a giant step in the drive towards environment protection.</p>

## 7.0 Process Description

### 7.1 Hazardous Waste Management Facility

Collection, transportation, reception, treatment, storage, re-use, recycle, blending and disposal of industrial hazardous wastes, bio-medical waste and E-Waste generated in the state of Telangana.

The proposed project is very unique to itself. The Facility shall be the first of its kind integrated waste management facility in the country. In fact it will be a giant step in the drive towards environment protection by the state of Telangana.

Hazardous wastes generated in the project area are expected to comprise of the following groups:

- ETP sludges
- Iron Sludges
- Still Bottom residues and process sludges
- Spent Carbon
- Evaporation salts/ other process salts
- Incineration ash
- Slags
- Asbestos and glass fibers
- Spent catalysts and resins
- Other hazardous wastes

Based on the quantities available the following general information could be inferred:

- ETP sludges can go directly to landfill either directly or after stabilization.
- Still bottom residues, process residues and other organic wastes can be sent for incineration including spent carbon depending on the characteristics of the impurities.

- Incineration ash, slags, asbestos and glass fibers are essentially inorganic in nature and can go to landfill directly or with simple stabilization techniques.
- Spent catalysts and resins would have to be characterized on a case-by-case basis to assess their nature and characteristics. However, the percentage of wastes generated through these sources is likely to be very small as most of it is taken back by the manufacturers.
- Salts will have to be bagged and land filled.

Based on the above compiled information wastes have been classified by their pathway of disposal:

- Wastes going to direct landfill
- Wastes that require stabilization prior to landfill
- Wastes requiring storage until alternate economically viable techniques are made available.
- Wastes requiring incineration

The following general guidelines shall relate to daily activities associated with the operations of TSDF:

- The facility shall operate only during day light hours throughout the year.
- The landfill will be staged in cells so that the minimum practical area of waste is exposed and maximum practical area of waste has the final cap in place i.e., progressive filling and capping of the landfill ensuring minimization of infiltration of wastes.
- The Weight Bridge at the main entrance will record all movements and weights and receive waste tracking receipt as required by the waste manifest system.
- The standpipe forming part of the leachate collection system shall be checked regularly for the presence of leachate. Once leachate is detected it shall be regularly pumped out and transferred to the leachate treatment facility on-site. The level of leachate in the standpipe shall not be allowed to rise above the level of the leachate collection system.
- Materials Safety Data Sheets (MSDS) for every chemical used or handled at the landfill shall be provided on the premises.
- Monitoring and auditing of the facility shall be performed on a periodic basic.
- Met-station shall be installed with continuous recording system.
- A security system shall be maintained to avoid trespassing and hazard to the public.
- Once a waste is received at the TSDF, a sample of waste shall be collected, at the sampling bay/temporary storage facility and shall undergo laboratory analysis based on which its pathway of treatment/ disposal shall be determined.
- A waste manifest system shall be developed in accordance with the requirement of the regulatory agencies to cover the transportation of the waste to TSDF and to provide for record of waste manifestation. The manifest system shall include details of the waste generator, waste transporter, quantity of waste, characteristics of waste, physical description, consistency of waste in terms of physical state and waste category number as per HW (M&H) Rules, 2003.
- Each load of waste arriving at the facility shall be located properly and logged to identify its pathway of treatment/ storage/ disposal.

- An inventory shall be maintained at the arrival and departure dates of waste loads in and out of the intractable waste storage area.

## **7.2 Waste Disposable Operations**

### **7.2.1 Waste Stabilization**

Waste stabilization is designed to convert industrial wastes in the form of liquids, semi-solids or reactive solids into low leachable materials that can be deposited into a secure landfill. The stabilization operation will be carried out for all waste that requires this to minimize their contaminant leaching potential. This will change the nature of these wastes to a less hazardous category. Stabilization involves the immobilization of leachable materials by fixation as non-reactive solids. The treated wastes shall be assessed for compatibility with other wastes before being landfill and for compatibility with the HDPE and the pipe network. The term stabilization covers a number of mechanisms including:

Immobilization / Chemical Fixation – the chemical binding of contaminants within a cementing structure to reduce the mobility or leach ability of the waste.

Encapsulation – the occlusion or entrapment of contaminant particles within a solid matrix.

Solidification – the conversion of slurries that do not readily de-water, into solids by addition of adsorption agents.

Typical reagents that would be used for the stabilization process include cement, lime, fly ash, bentonite clay, saw dust and other. Where required sodium silicate solution would be used as an additive binding agent. The reagent to be used for stabilization shall be decided depending upon the type of the waste to be stabilized, price and availability. These reagents shall generally be stored in sufficient quantities. The Infrastructure proposed for the stabilization unit would include:

Storage facilities for reagents, Tanks/Drums for storage of reagents as required, Stabilization bins for mixing the wastes, Earth moving equipment for movement of wastes and mixing, Place for curing the treated waste, Trucks for hauling the wastes.

Treatment facility utilizes a range of techniques and processes designed to change the physical, chemical or biological characteristics of the waste. This may include changing the composition so as to neutralize the waste, to recover energy or natural resources from the waste, to render the waste non-hazardous or less hazardous, safer to transport, store, or dispose off or to reduce its volume. Typical operations at Stabilization unit are as follows:

Waste receive, Reagent addition, Mixing, Curing, Analysis of the stabilized wastes, Approval by the laboratory for disposal, Transfer of the waste materials to the truck, Disposal in the secured landfill

Application criteria: A study of the waste characteristics carried out as an integral part of the project indicates the following applicability to the process described below in **Table 3**

**Table 3**  
**Stabilization Mechanism based on Waste Characteristics**

Mechanism	Applicability
Immobilization / Chemical Fixation	Heavy metal and metal plating sludge Copper-chromium-arsenic wood preservative wastes Mercury waste Bag house dust Tannery wastes Spent catalysts Others
Solidification	Effluent treatment plant sludge Oil and paint sludge Bitumen wastes Textile industry sludge Wool scouring slurries Others
Encapsulation	Aluminum powder Asbestos Filer aids Others

### 7.3 Landfill

The landfill will be designed and constructed as a secure facility to contain the waste material and any leachate, which is formed by the entrapped moisture or by infiltration of rainfall. To meet these requirements the base of the landfill has been designed as an engineered liner constructed prior to the placement of waste and also an engineered capping over the surface after completion of filling to minimize the infiltration of rainfall.

The base liner of the landfill containment system is proposed to be a double composite liner with synthetic geo-membrane plus clay. Adequate leachate collection system shall be incorporated at the base to collect and remove the leachate. These shall incorporate HDPE pipes embedded in drainage layers of sand/ gravel and /or geonet/ geotextile. The composite liner (Secondary liner) shall comprise of a 0.45 m thick clay compacted to a permeability less than  $10^{-9}$  m/s and above this shall be a HDPE liner with permeability less than  $10^{-14}$  m/s above which a complete drainage system shall be placed. Above the secondary base liner shall be placed a primary liner comprising of primarily clay layer and HDPE membrane which will prevent infiltration into the secondary layer. A leachate collection and removal system shall also be placed over the primary liner to collect and remove any leachate generated by infiltration of precipitation or by the moisture entrapped in the waste. This makes the secondary system to serve as a leak detection system and an early warning of potential future liabilities to necessitate action for remediation. Above the drainage system of the primary liner shall be placed a geo-textile filter to act as a filter/ barrier between the waste and the drainage system. This entire system would make the base liner a double composite liner meeting the national laws.

Clay Liner consists of a varying proportions of hydrated aluminum silicates (e.g. kaolinite, bentonite, illite and montmorillonite) which, when properly compacted, form a soil mass with a very low hydraulic conductivity. The clay material for use as the liner at this landfill shall be analyzed and permeability testing shall be carried out to ascertain its low permeability. Design permeability of the clay liner has been fixed at  $10^{-09}$  m/s and with availability of clay liner; we will be able to achieve better results than the design values. Placement of clay liner shall be most critical in terms of its efficiency of functioning. Clay should be placed in layers not exceeding 200 mm and shall be compacted to attain the required permeability. The clay layer after attaining the 0.45m thickness should be then checked for its permeability. Further to this, clay shall be kept moist to ensure that it does not dry up and cause cracks to the lining system. To ensure this we intend to keep the clay for the purpose at +4% wet of optimum moisture content.

Synthetic Liners consists of various synthetic flexible membrane liners have been considered for use as the primary liner at the proposed landfill. Both Poly-Vinyl Chloride (PVC) and High – Density Polyethylene (HDPE) liners are generally suitable for this landfill. Tensile strength is a fundamental design consideration in order to assess the ability of the liner to resist uniaxial and biaxial strains, which occurs in the landfill. Another stress strain consideration is the coefficient of thermal expansion.

Considering various membrane properties it is decided to use HDPE liner with appropriate thickness as primary liner for the base of the landfill. HDPE was selected for the following reasons:

- Adequate strength to withstand mechanical strength during construction, placement and operations.
- Acceptable weathering performance.
- Superior physical properties under chemical and environmental exposure to wastes  
Capability to withstand the seaming process.
- The hydraulic conductivity of HDPE is of the order of  $0.5 * 10^{-16}$  m/sec, which is effectively impermeable. Construction of the seam welding process shall be subjected to strict QA/QC measures to ensure the integrity of the liner.

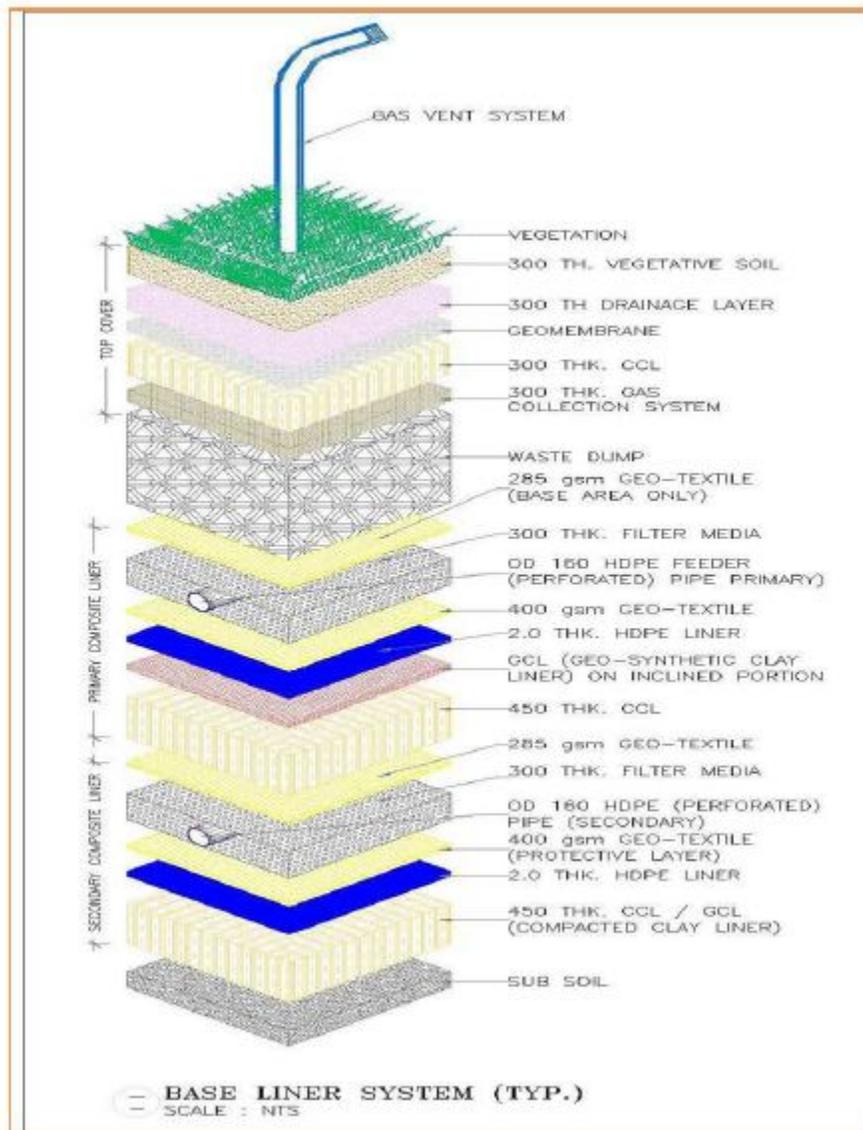
Secure Landfill is the final placement area for land fillable hazardous wastes which are treated or wastes does not require treatment. Waste directly or after treatment will be disposed in the landfill as per the laboratory advice. Waste will be spread in the landfill using heavy earth machinery and then compacted using vibro compactor. At the end of the landfill operations  $10^{-15}$  cm soil cover is placed as a daily cover. During rainy season a flexible geo-membrane cover shall be placed over the uncapped area of the landfill minimize infiltration of rainfall into the landfill; the rain water shall be diverted to join the surface water drains. At the end of the total landfill operations the final capping shall be done using composite liner with clay and synthetic geo-membrane, with vegetative soil cover grass cover.

### **7.3.1 Leachate Collection/Treatment and Disposal**

Leachate collection and removal shall be provided above the geo-membrane in two layers viz., the primary and the secondary liners. The primary liner shall serve as leachate collection and removal system, while the secondary liner shall serve as leak detection system and a

signal of potential liabilities in terms of environmental pollution. Leachate shall be collected by a network of lateral and header pipes embedded in a drainage layer, all of which shall eventually drain into a leachate collection sump. The collected leachate shall be transferred to a leachate treatment system.

The leachate collection system in an engineered landfill takes the form of an under-drain beneath the waste material it is required to ensure there is no more than a limited head of pressure above the base liner to cause leakage of liquid from the base of the landfill. The design maximum pressure head in the proposed landfill shall be limited to 300mm. the detailed landfill cross section is given in **Figure 3**



**Figure 3 Landfill Cross Section**

Drainage is affected by a layer of about 300mm thick of graded sand/gravel having a high permeability. Within this layer a network of HDPE pipes are placed to collect leachate and conduct it quickly to the collection sump for removal from landfill. The pipes are typically perforated only over the upper half to allow the leachate to enter the pipe and thereafter to be contained within the pipe network system. The layout of the pipe network generally includes sufficient redundancy to ensure that if a blockage occurs somewhere in the network the leachate simply backs-up a little then flows into the system a little further up-gradient. Two layers of the leachate collection system shall be provided one over the other. Slotting area of the pipe shall be done only on the top 120 portion of the pipe and to an extent of 100 cm<sup>2</sup> per running meter of the pipe.

The key design features of the leachate collection system to be installed at the proposed landfill comprise the following:

A network of semi perforated HDPE pipes laid out directly over the primary and secondary liners and graded towards the collection sump at no less than 2% slope, with a slotting area of 100 cm<sup>2</sup> per running meter of the pipe.

A drainage layer 300mm thick of graded sand/gravel placed over the entire base of the landfill, covering the pipe network.

A geo-textile placed over the primary liner serving the purpose of filter/ barrier between the waste and the drainage media.

The pipe shall have sufficient strength to withstand the load imposed by the overlying waste and the earth moving activities associated with the placement and the compaction of the waste (Min 6 Kg/ Sq.cm).

### **Drainage of Surface Runoff**

Network of open channels shall be designed and constructed around the landfill to intercept surface runoff of rainwater and divert it around the facility or collect it for the use at the facility or for disposal. Storm water collected on the landfill site will be directed to a first flush retention pond which shall be designed for a sufficient capacity to cover a 1 in 100 years 10 minutes storm event. In particular the storm water system will be designed and implemented to prevent surface runoff entering the landfill and thus minimizing the leachate.

### **Wastewater Treatment Plant**

Leachate collected from Secured Landfill and other wastewater including vehicle and container washing, leachates generated at treatment, incineration, recycling plants are treated together (excluding domestic wastewater). Leachate from the landfill and all other places of generation like storage sheds, vehicle wash, and wheel wash etc., will be recycled back into the process. The dry residue from the solar evaporation pond / incinerator will be handled as a solid waste and will be disposed in the landfill.

## **Incinerator**

Incineration is an ultimate treatment process, applied to certain wastes that cannot be recycled, reused or safely deposited into a landfill. It is a high temperature, thermal destruction oxidation process in which hazardous wastes are converted in the presence of oxygen in air into gases and incombustible solid residue. The gases are vented into the atmosphere with cleaning as deemed necessary while the solid residue is sent to landfill for disposal. The proposed incinerator would cater for the disposal/ destruction of the following wastes:

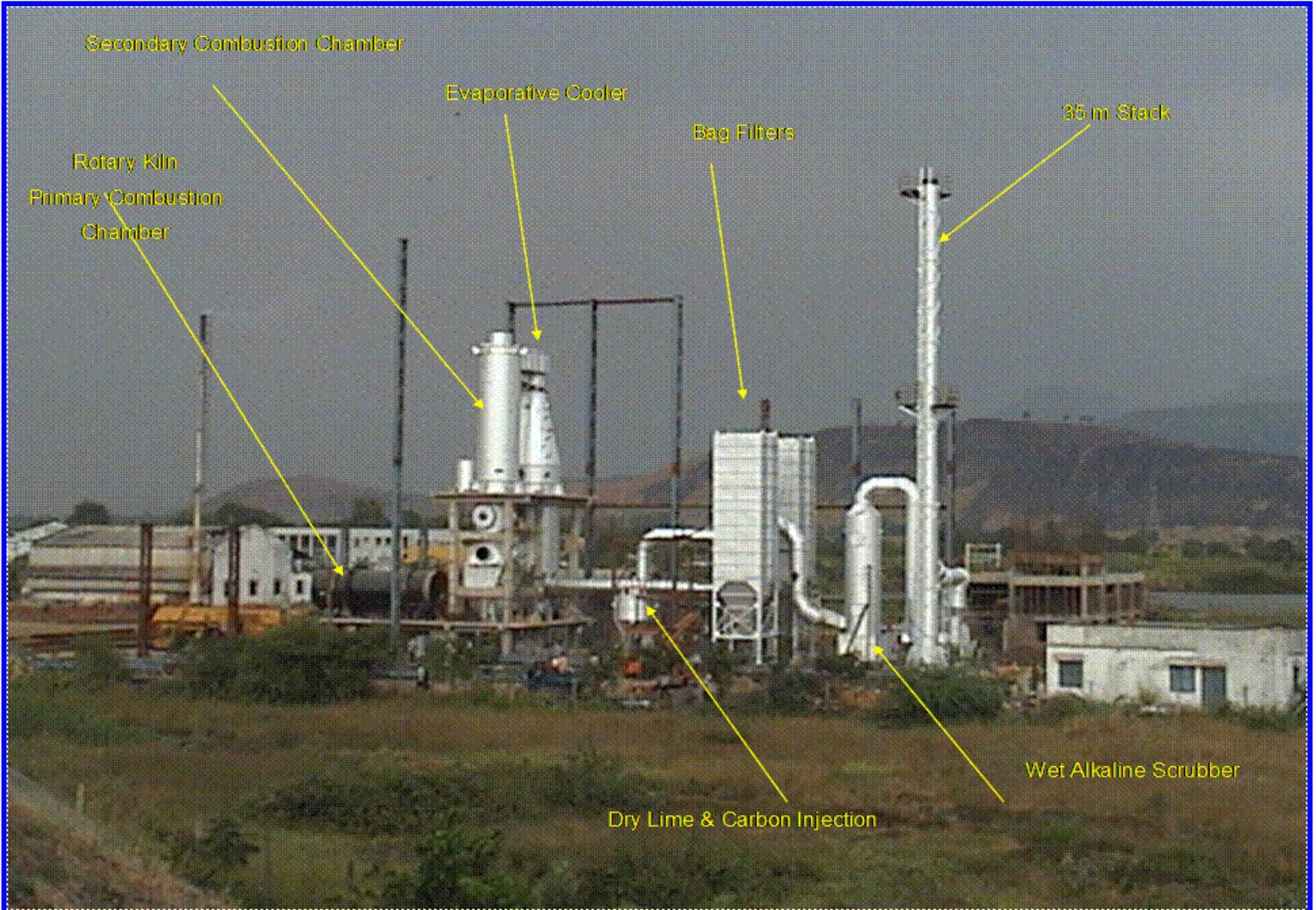
- Spent Solvents
- Waste Oils, Oil Emulsions and Oil mixtures
- Pesticide Wastes
- Refinery Wastes
- Pharmaceutical Wastes
- Phenolic Wastes
- Grease and Wax Wastes
- Organic wastes containing halogens, sulphur, phosphorous or nitrogen compounds
- Solid materials contaminated with oils.
- Organics with high calorific value

The primary objective of this incinerator is to destroy the wastes as completely as possible, to have end products (solids and gases) that are harmless when released from the incinerator and to minimize the formation of new hazardous organic compounds. To achieve the same the incinerator is proposed with sufficient temperature, time and turbulence and in presence of excess air. Incinerator is the facility for final disposal of incinerable wastes. Wastes which are not fit for disposal in the landfill and are candidates for incineration shall be disposed in the incinerator. The wastes shall be pre-processed in case of necessary for making it uniform calorific value and maintain the norms of halogen concentrations less than 1% and all.

Wastes are fed through cart dumper and ram feeder into the rotary kiln and the hot gases are sent to the secondary combustion chamber. The residence time and the desired temperatures are maintained at both primary and secondary combustion chambers for complete combustion as per CPCB guidelines for hazardous waste incineration. The gases after complete combustion shall be sent to spray drier / evaporative cooler for cooling followed by Gas cleaning equipment.

The gases are passed through multi cyclones for removal of particulates. Then dry lime and activated carbon are injected for neutralization of acidic gases and removal of organic constituents if any. The flue gases then passed through bag filters for complete removal particulates and then through wet alkaline scrubber for neutralization. The flue gases after completely cleaned in all respects shall be sent out through a 30 m stack. The ash generated during the combustion process and collected at the bottom of the hopper will be send to landfill facility. The typical layout of the Incinerator is shown in **Figure 4** below

**Figure 4**  
**Typical Layout of Incinerator**



## **7.4 Bio Medical Waste**

Growth in population, industrialization and changing life styles and food habits have brought with it various health related issues. More and more people are suffering from ailments. Alongside this is the growing awareness towards utilizing proper medical facilities. This has created the need for a whole range of health care establishments, hospitals, clinics, laboratories which are generating “Bio-Medical Wastes” that are incompatible with the environment. These wastes need professional attention for effective management as the infectious nature of the waste can cause irreparable damage to the human health and the environment. It has become imperative to monitor and control the management and handling of these wastes.

The concern about disposal of infectious wastes generated by the hospitals is increasing rapidly due to the fear of the spread of viruses such as Acquired Immune Deficiency Syndrome (AIDS) and Hepatitis B. These wastes (bio-medical wastes generated from health care establishments) present a high risk of causing potential damage to the human health and the environment by way of spreading. To prevent the spread of such infectious wastes that finds its genesis in bio-medical wastes (from hospitals, clinics, laboratories, dispensaries etc.) a scientific approach is required. It is essential that professionally trained personnel should handle the wastes and that the wastes should be disposed scientifically.

To enable effective management and handling of the bio-medical wastes, the Ministry of Environment and Forests (MoEF) has issued regulations for the management and handling of these wastes. In response to these rules, Government and major Private Hospitals initiated their arrangements for treatment and disposal of bio-medical wastes. However, the smaller nursing homes, clinics and other similar institutions which do not have or can afford such facilities need alternate modalities and arrangements to dispose their wastes, in accordance with the Rules.

In view of the difficulties faced by private hospitals, nursing homes and clinics that could not make their own arrangements due to high cost involved in setting up treatment and disposal facilities, the need for a centralized system for treatment was felt. Consequentially, in September 2003, the Central Pollution Control Board enunciated the “Guidelines for Common Bio-Medical Waste Treatment Facility” which in addition to providing common facilities discouraged the set up of individual incineration facilities by health care establishments.

### **7.4.1 Waste Classification and Characterization as per BMW rules**

Wastes generated by the hospitals can primarily be classified into 3 groups:

**Conventional Wastes/ Municipal Solid Wastes:** General refuse similar to the domestic/ municipal solid wastes and includes artificial linens, paper, food, cans, diapers, and plastic cups. This waste is non-infectious if it is not brought in contact with the infectious wastes and properly managed.

**Hazardous Wastes:** Laboratory and Pharmaceutical Chemicals and containers including off-specification and other chemicals, alcohols, disinfectants, anti-neoplastic agents, heavy metals (e.g. Mercury), etc. These wastes are hazardous in nature and if properly segregated and managed can be transported to hazardous waste management facility for treatment/ storage/ disposal.

**Infectious Wastes:** Commonly referred to as Clinical and pathological Wastes and include: isolation wastes (refuse associated with infectious patients), cultures and stocks of infectious agents and associated biological, human blood and blood products, pathological wastes, contaminated sharps, amputated body parts, placenta and others.

Typical wastes falling under each of the above groups of infectious wastes is presented in the **Table 4** below

**Table 4**  
**Categorization of Infectious Wastes**

Waste Group	Typical Wastes
Isolation Wastes	Wastes from patients with diseases considered communicable and requiring isolation
Cultures and Stocks of Infectious agents and associated biologicals	Specimens from medical and pathological laboratories Cultures & stocks of infectious agents from clinical, research, industrial laboratories, disposable culture dishes, & devices used to transfer, inoculate and mix cultures Wastes from the production of biological Discarded live and attenuated vaccines
Human blood and Blood Products	Waste blood, serum, plasma and blood products
Pathological Wastes	Tissue organs, body parts, placenta, blood and body fluids removed during surgery, autopsy and biopsy.
Contaminated Sharps	Contaminated hypodermic needles, syringes, scalpel blades, Pasteur pipettes and broken glass.

**Collection and Transportation**

Bio-medical waste will be collected from each health care establishment on a regular basis. Wastes shall be segregated as per the color coding, properly packed and placed at a secure designated point by the health care establishment from where it will be collected. Upon collection wastes shall be placed into closed containers enclosed in a containerized vehicle and transported to the site. The vehicles shall be dedicated for the purpose and shall adopt the conditions specified in the BMW (Management & Handling) Rules-1998.

**Disinfection and Destruction**

Upon receipt of the waste at the facility, wastes containers shall be unloaded. Wastes based on their colour codes shall be separated and properly treated and disposed off. Categories 1, 2, 3 and 6 (as per MoEF rules) shall be directly loaded into the incinerator while categories 4 and 7 shall be loaded into the autoclave for dis-infection. Ash, residue from high temperature incineration and other material residues from the process shall be collected into containers and shall be disposed into a secured landfill.

### **Bio Medical Waste Incineration**

The incinerator proposed for Hazardous waste will be used for incineration of Bio-medical Waste also, hence it is a common facility for incineration of all incinerable wastes coming to the facility.

### **Autoclave**

The primary purpose of autoclave is to sterilize / disinfect the waste with steam. Micro organisms which contribute to infection do not survive beyond 80°C. However, as a precaution MoEF has stipulated a temperature of 121° C with 15psi pressure and 60 min duration to ensure distribution of temperature. At this temperature and pressure, micro organisms are completely destroyed and thus render the wastes infection free. The disinfected waste shall then be segregated into HDPE, PP, rubber, latex, glass and metal. The segregated materials shall then be shredded completing the process of disinfection and ensuring non-recycling of the waste materials for medical / food grade purposes. All the process control conditions will be as per the applicable Bio medical rules.

### **Autoclave Features**

A vacuum type (programmable) autoclave which can operate at all the specifications mentioned by MoEF with a capacity to handle 2 T of medical waste per day is proposed. The autoclave shall have continuous and automatic recording of temperature, pressure, date, time and batch of loading. Every batch shall be monitored with a strip chart recorder and once in a month the spore validation test and/or spore monitoring shall be done. Following are the key features of the proposed autoclave:

Type: Vacuum Type, automatic with documentation.

Capacity:	2 Ton per day
Temperature:	135°C
Pressure:	35 psi
Time:	45 min
Automation:	PLC with MMI ( Man-Machine interface)
Documentation/ Recording:	Computerized recording

The Layout of typical autoclave process is given in **Figure 5** below

## Other Infrastructure

The other infrastructure proposed in Bio-medical Waste Treatment Section is as follows

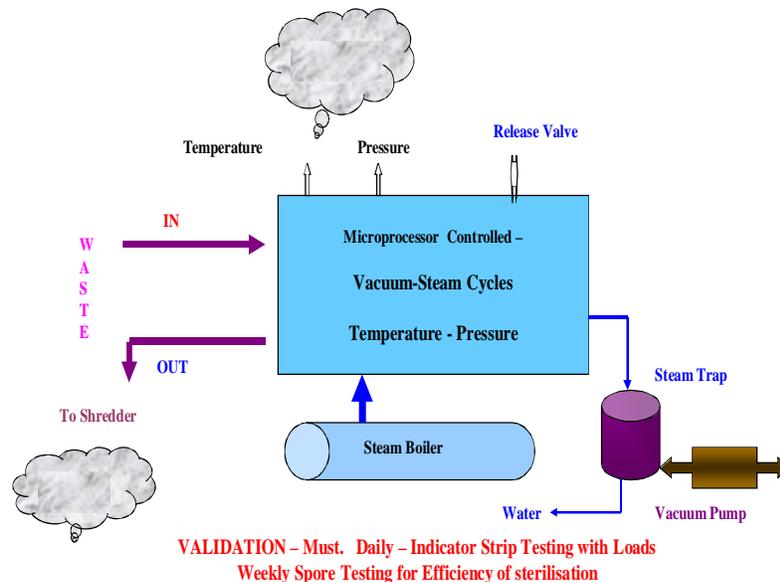
**Effluent Treatment Plant:** An ETP to treat the scrubbing water, floor washings and other wastewater from the plant and send the same for circulation into the scrubber. The system shall be cooling, pressure sand filter and activated carbon filter assembly followed by neutralization before recirculation into the scrubber.

**Shredder:** A mechanical shredder to make the waste unrecognizable as medical waste shall be installed with a capacity to handle about 3.3 T of medical wastes per day.

**Landfill:** The residue will be sent to secured landfill site.

**Figure 5**  
**Autoclave process**

## Sterilization Process



## 7.5 Integrated E Waste Recycling

The assessment of e-waste recycling sector in India indicates that e-waste trade starts from formal dismantling sector and moves to informal recycling sector. There are no large scale organized e-waste recycling facilities in India at present except few in some states of India, while most of the e-waste recycling units are operating in un-organized sector. So, this will be an opportunity for us to serve the industries by handling their E-waste. The main objective of the proposed E-Waste facility is given below.

- To provide Safe and Secured Destruction services at project site to ensure intellectual property assurance.
- To provide innovative and pollution-free technology for recycling of E-waste.
- To provide Environmental management system and solutions.
- To recover up to 99% of total waste received
- To enhance customer service through online account access.
- To conserve natural resource & ensuring working towards global warming
- The proposed project consists of the following facilities
- Fully integrated state-of-art E-Waste management facility
- World class security systems
- Certified, Safe and Secured destruction services
- Comprehensive EHS practices
- Logistics, warehousing facility
- Highly skilled manpower

### **Methodology:**

The methodology proposed to be followed at the E-Waste facility is as follows. The process flow sheet is given as Figure below.

Upon client request, project management shall arrange a suitable and secured transport to collect the material from Clients premises.

Collected material shall be weighed, if desired by clients at their premises using their own weighing machine and witnessed by both parties.

Manifest to be issued by generator to transport with 6 colored copies as per HW Rules, 2008. Delivery Order will be issued by Client prior to collection from their premises. Collected material is to be provided in good packaging condition and thereafter will be transported to the facility.

After inspection by project security guard, material shall be weighed at site weighbridge to determine the gross weight of the material and will then be sent to its warehouse for acceptance.

Goods Receive Note (GRN) for the gross weight will be issued upon receiving the material at the warehouse.

Material will then be sent for dismantling section under IDO (Internal Delivery Order) for dismantling.

Destruction process can be witnessed by Client, if required.

Upon data destruction completed, official destruction certificate will be issued to Client for records.

Dismantled material will then be sent to suitable recycling process.

### **7.5.1 Process Description:**

The process involved in proposed integrated E Waste recycling facility is basically physical destruction and recovery of Platinum Group Metals (PGM's). The steps of proposed process is described in following paragraphs

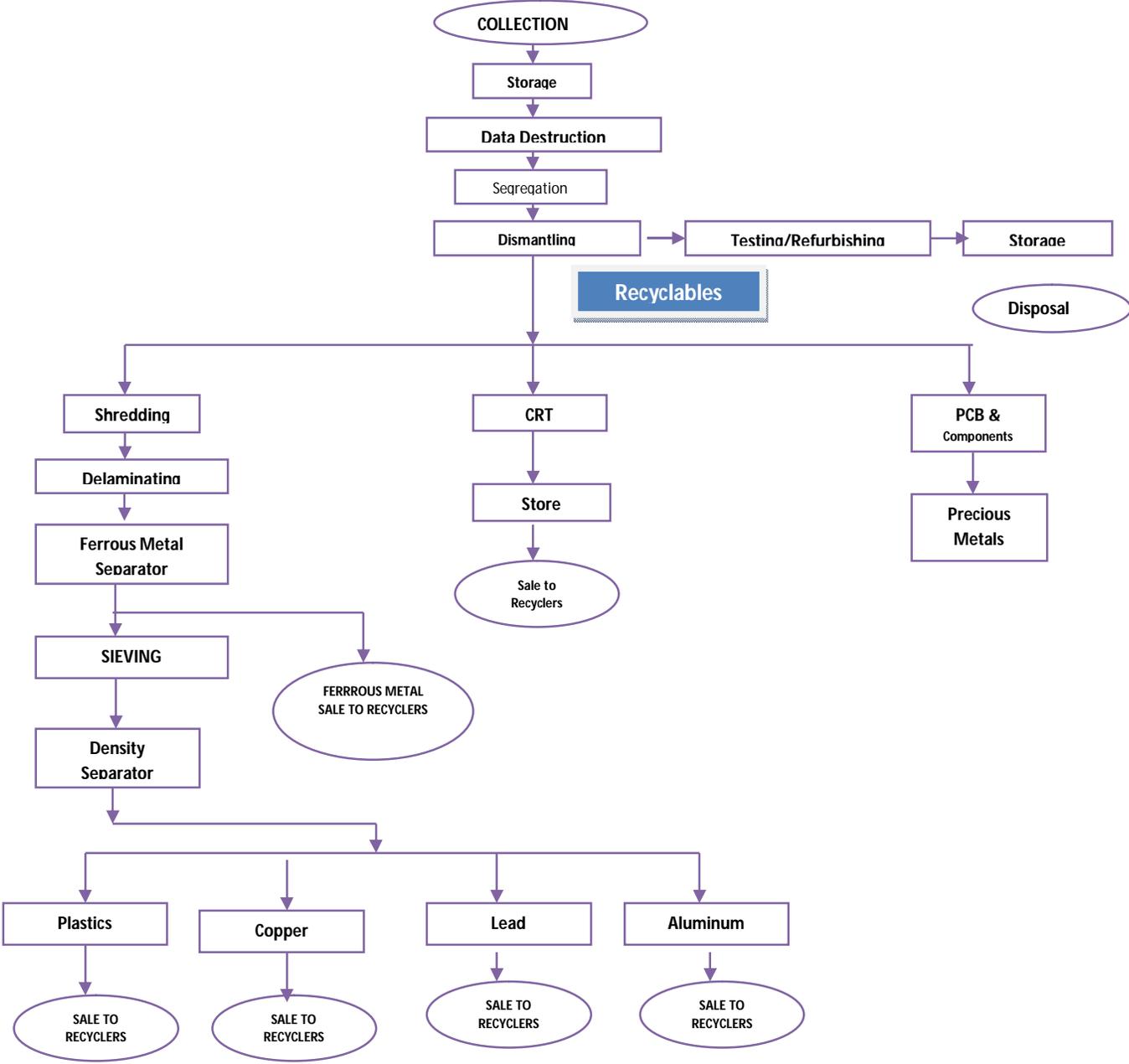
The e-waste received from generator shall be stored at earmarked covered shed having concrete floor and leak proof roof. Wooden or plastic pallets shall be provided to store the waste.

Waste which may contain mainly electronic and electrical material and monitors of computer or TV's, shall be shifted to manual dismantling section in hand trolleys

A set of 8 to 10 no. of work stations are proposed with a suction hood for any dust particle coming out of the dismantling process. A team of experts in dismantling shall be deputed for dismantling purpose with all the required tools and tackles. The tools and tackles shall be identified with best available brand to ensure optimization in working and to avoid small accidents in the process. The employees at this section shall be provided with all the required PPE's i.e. apron, safety shoes, gloves, dust mask etc. Fire extinguishers shall be provided in the working area.

The team deputed shall dismantle all the waste articles Eg computer CPU box, hard drive, CD ROM, cables, PCB's etc. and monitor into back cover and picture tube. The hard drive, PCB's shall be further dismantled into components attached and naked PCB's. Flow chart of the process is given in **Figure 6**

**Figure 6**  
**E Waste proposed Flow Chart**



The dismantled PCB's shall be sent for shredding followed by crushing and pulverizing. The product shall be powder of PCB from which metal and non metal part which shall be segregated by physical process. Both the products shall be stored in bags for disposal for recovery (metal part) and for making of toys and monuments (non metal part). In case the non- metal part fails to be recycled, the same shall be disposed into incinerator as this consists of residue with high C.V.

The dismantled picture tube shall send to Cathode Ray Tube (CRT) cutting m/c, which is a closed chamber attached with a hood connected to cyclone and bughouse. The CRT shall be put into the control panel connected automatic CRT cutting frame. The CRT shall be cut into two pieces i.e. front glass and funnel glass.

- The glass which is free from all coating etc shall be crushed further and stored in bags to be dispatched for recycling
- The components removed from PCBs shall be segregated and stored in bags for further disposal and/or reuse.
- The ferrous material i.e. cabinet, body of monitor etc shall be baled and disposed for recycling
- Plastic from cabinet, monitor shall be shredded in the shredder and sold out for recycling to authorized recyclers
- The chemical process for recovery of PGM shall be established during phase – II

The waste generated from above process shall be stored at earmarked area and not allow the waste to be exposed to the environment.

- Recycling Facilities
- The recycling facilities proposed for the site are
- Spent solvent recycling
- Used oil recycling
- Alternative fuel recovery facility
- Lead battery acid recycling facility
- Waste plastic recycling
- Waste paper recycling
- Renewable energy
- Waste to Energy
- Spent Solvent Recycling
- Spent solvents are recovered using a distillation methodology. Following are few solvents proposed to be separated /distilled initially:
- Isopropyl alcohol
- Butanol
- Dimethyl formamide
- Toluene and
- Ortho dichloro benzene
- Storage of spent solvents

The waste solvent shall be received in drums (MS/Plastic) and shall be stored in shed which will be provided with garland drain, fire hydrant system, lined floor etc.

The drums shall be stacked as per the best practices. The leakages shall be avoided at any point of time.

A separate storage shed sized 35 X 40 m is proposed adjacent to facility to store the solvent drums.

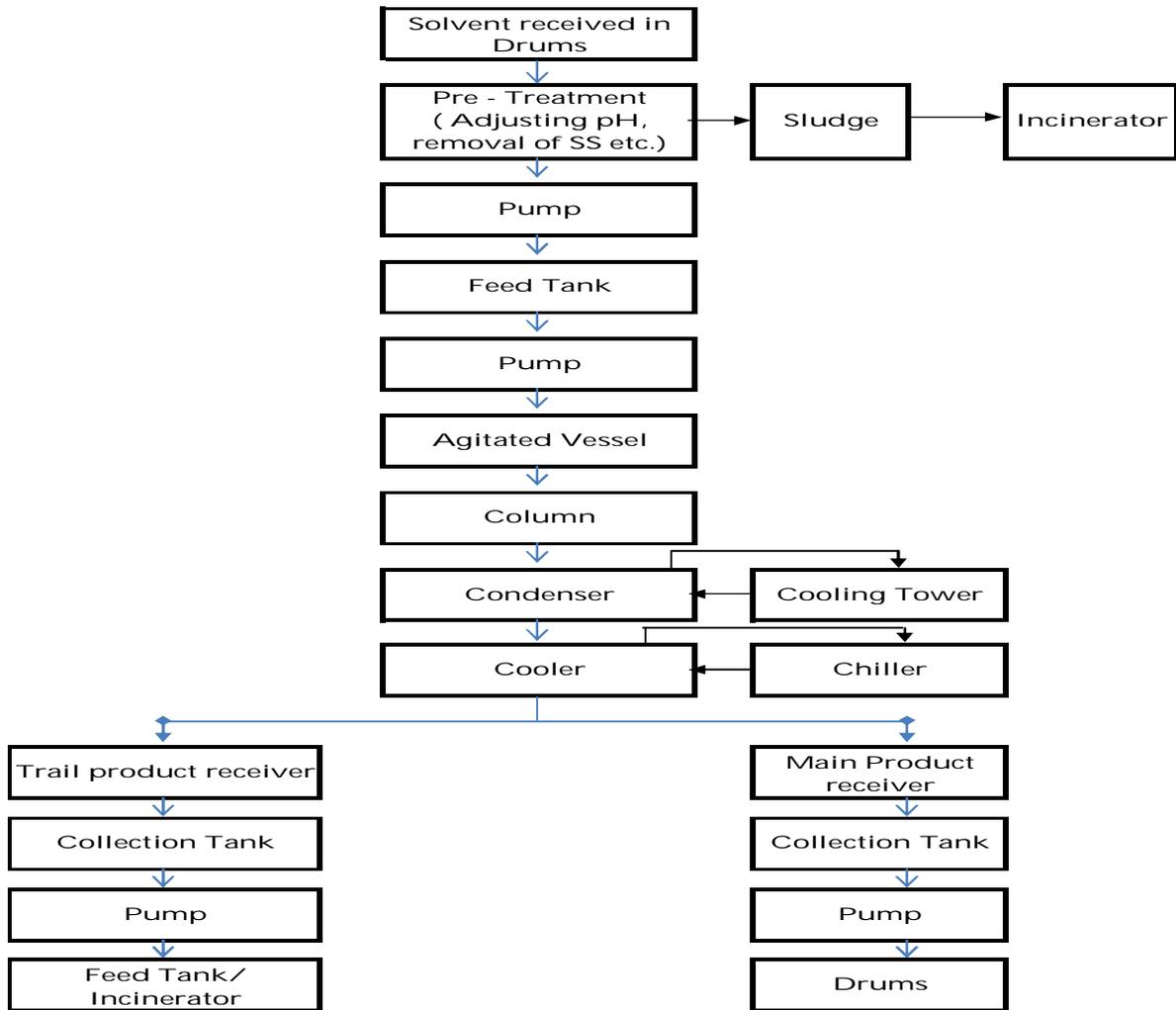
The stacking of drums shall be in the manner that mixing of solvent drums shall be avoided at maximum extent.

Distillation process is suitable for the recovery of many spent solvents. Distillation can be a batch or continuous operation. It is proposed to adopt batch process in the proposed facility. The process involves pre-treatment of neutralization and separation of spent solvent feed mixture in a Reactor. After layer separation, the spent solvent mixture will be sent to distillation still connected to distillation column. The solvent mixture is heated by steam and the distillation column will be under total reflux for a specific period. Fractionation of solvent takes place solvent / water as the case may be are separated initially under atmospheric pressure and later under vacuum (if required). Distilled solvents are analyzed, stored and recycled, liquid effluent mostly condensate will be recycled back into system and solid residue sent for incineration / landfill. Steam for heating will be donor from the boiler. The process diagram of the solvent recovery is depicted below:

### **Process Description**

Distillation can be a batch or continuous operation. It is proposed to adopt batch process in the proposed facility. The process involves pre-treatment of neutralization and separation of spent solvent feed mixture in a Reactor. After layer separation, the spent solvent mixture will be sent to distillation still connected to distillation column. The solvent mixture is heated by steam and the distillation column will be under total reflux for a specific period. Fractionation of solvent takes place solvent / water as the case may be are separated initially under atmospheric pressure and later under vacuum (if required). Distilled solvents are analyzed, stored and recycled, liquid effluent mostly condensate will be recycled back into system and solid residue sent for incineration / landfill. Steam for heating will be donor from the boiler. **Figure 7** below shows the Flow Chart of Spent Solvent Recovery

**Figure 7 Flow Chart of Spent Solvent Recovery**



## 7.6 Used Oil Recycling

Used oil is termed as hazardous. Lube oil does not wear out with use it only gets contaminated with water, carbon and fuel etc. that means used oil when it is ready for rejection can be re-used.

The methods of disposal being followed are Dumping, Burning or Reprocessing. The Used / Waste Oil generated are not easily biologically degradable. Therefore, dumping of Used / Waste oil is harmful to environment.

Burning of Used / Waste Oil is not desirable for the following reasons:

Waste Fuel Oil contains substantial quantity of water that will prevent proper burning of fuel and lead to generation of carbon monoxide.

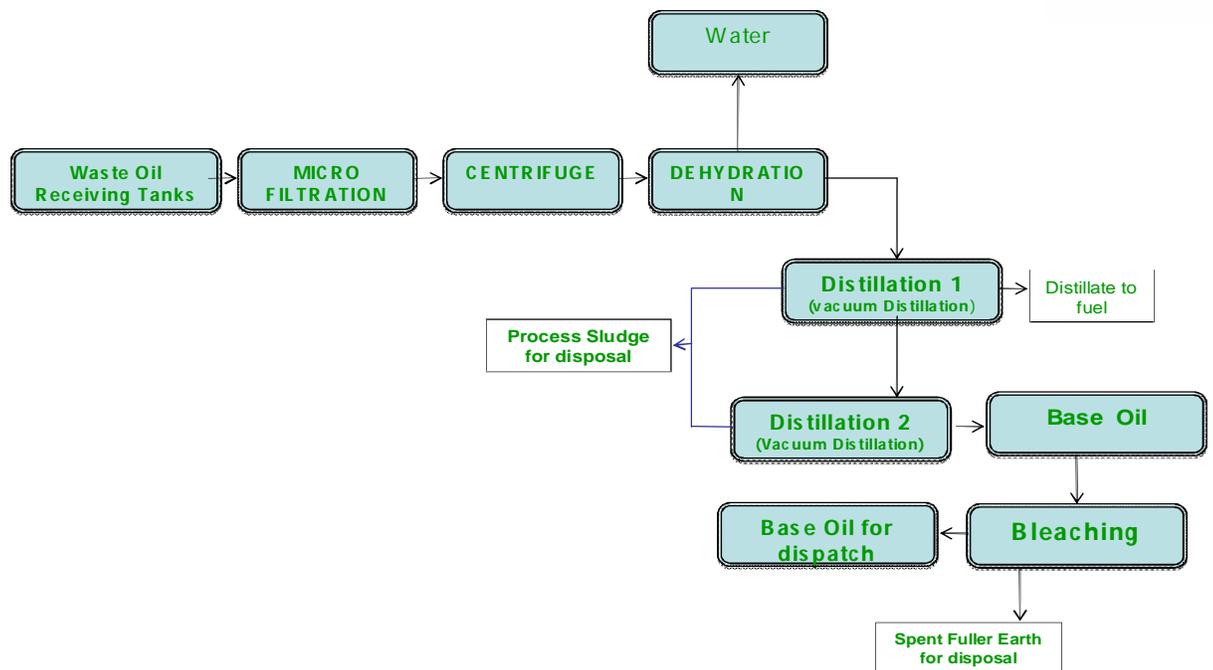
The Used Oil (used lubricants, Transformer oils etc), they may contain chemicals, metallic compounds, Polychlorinated Biphenyl (PCBs) etc which when burned will release gas to the atmosphere. Therefore, burning of used / Waste Oil should not be encouraged.

The other option is Reprising. Improper reprocessing methods can lead to generation of waste which is even more hazardous than Used / Waste Oil.

Therefore, reprocessing should be allowed only with approved methods. Reprocessing of Used / Waste will not only be a solution for disposal of waste but it will have tremendous economic advantage.

The process diagram of the waste/ used oil recycling plant will be as below in **Figure 8** below

**Figure 8 Used Oil Recycling**



### 7.7 Alternative Fuel Recovery

Alternative fuel platforms will be developed with in a area of 25 x 50 m as below:

“S” Type Alternative Fuel Preparation Facility	“L”Type Alternative fuel preparation Facility
---	--

'L' Type Alternative Fuels Area:

'L' Type Alternative Fuels are basically Liquid Type Incinerable Waste which are more than 2500 Kcal.

Common Neutralization Tank to maintain pH level 7

25 KL Mixing Tank with Cooling Coil and External Jacket to control the heat for Exothermic Liquid Waste

25 KL Mixing Tank for the Non-Exothermic Liquid Waste

Agitator set up made by Stainless Steel

Pump

'S' Type Alternative Fuels Area:

'S' Type Alternative Fuels are basically Solid Type Incinerable Waste which are more than 2500 Kcal

Common Neutralization Tank to maintain pH level 7

Mixing pit of 5 x 5 m

Jaw mixer for premixing of the solid and semisolid Waste.

Blender

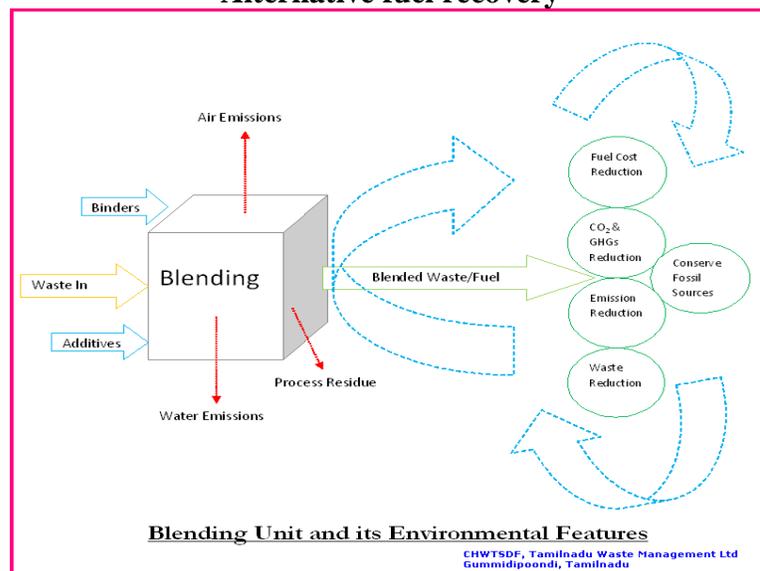
Solid blend is prepared through mixing in an appropriate quantity of solid/ semi solid waste with binders. The first step of preparing solid blend is to selection of waste.

The segregation of waste according to their pH & calorific value helps in it. Source materials for solid substitute fuel include Paint Sludge, Oily Filter Cake, Spent Carbon, Organic waste, Tarry waste, Biomass, Resin, Distillation Residues, Grease, ETP sludge, and alumina sludge etc.

Assortment of waste is done according blending norms.

A general waste selection criteria for high calorific value fuel is Low moisture content, High LOI & TOC, High calorific value, Good compressibility, Less ash content, Non toxic, Less pollutant, Sustainable combustion. Schematic Diagram for the Alternative Fuel Recovery is shown in **Figure 9**.

**Figure 9**  
**Alternative fuel recovery**



## **7.8 Lead Battery Acid Recycling**

Lead is one of the most vital nonferrous metal having multiple uses like in lead acid batteries, cable covering, alloying elements in solders, nuclear shield etc, and in terms of its chemical it is used in glass, paint and as an important stabilizers in PVC as lead striae etc.

Almost 70 to 80 % of lead productions come from recycling and balance 20 to 30% from virgin sources that is lead concentrates. The requirement of lead is going up at the rate of 15 to 20 % annually. Its requirement is going up more in developing countries like India and China. Further almost 70% of the lead goes in to the production of lead acid batteries. Demand for lead acid batteries is going up almost at the rate of 20 to 25% in India & China.

In India only Hindustan Zinc Limited and two other producers in smaller quantities produce lead from lead concentrates. Rest of the lead production is either from recycling or imports. Since more & more scrap lead acid batteries and other scrap of lead will be available there is a good scope to recover lead in an environmentally friendly manner.

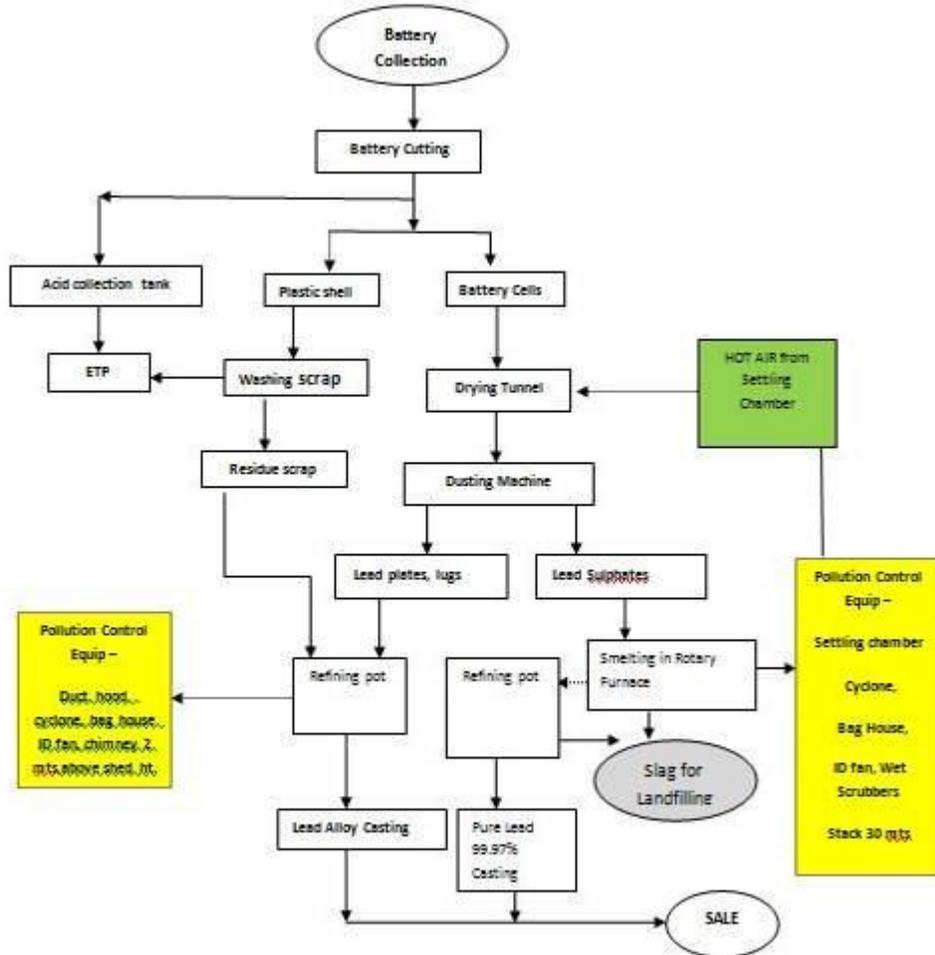
### **7.8.1 Lead Recycling Process**

Extraction of Lead from used Lead Acid Battery Plates, Lead Scrap, lead dross and other lead bearing wastes is carried out by using Rotary Furnace and Reverberatory Furnace.

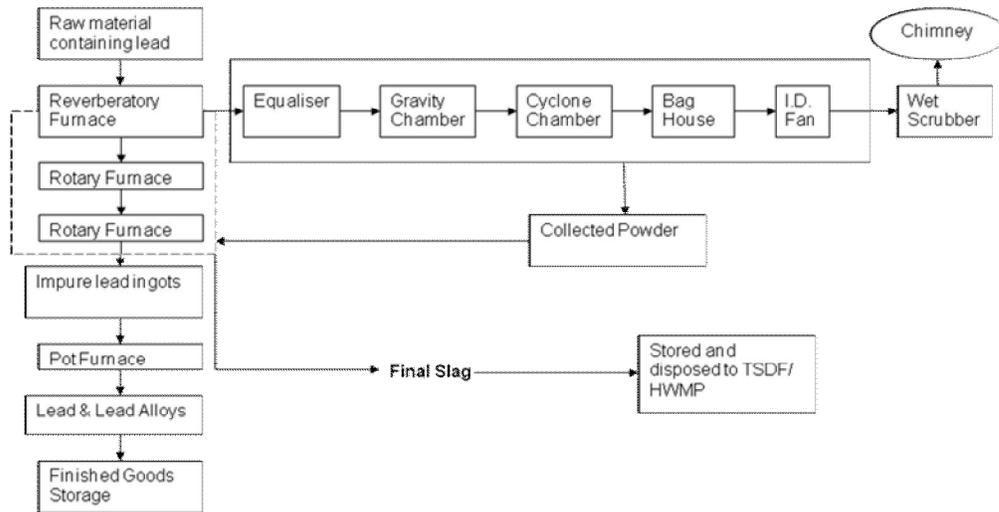
Conventional method of lead extraction from used lead acid battery plates, lead scrap, lead dross and other concentrate generates huge amount of sludge which becomes very difficult for disposal in the landfill. However, the combination of Rotary furnace and Reverberatory furnace with high calorific furnace oil as fuel reduces the quantum of slag generation and improves the recovery of lead metal considerably. Furnace oil will be used as fuel to melt the battery and other scrap.

The schematic diagram of the lead recycling is shown in **Figure 10** & Schematic Diagram of Lead and Lead alloys manufacturing **Figure 11** given below

**Figure 10  
Lead Battery Recycling**



**Figure 11**  
**Schematic Diagram of Lead and Lead alloys manufacturing**



The Reverberatory furnace is filled with the charcoals and ignited by using the blower. The blower supplies the required combustion air for burning the charcoal. After a sustained fire, the lead scrap (raw material) is fed into the furnace. The metallic lead in the scrap melts and the oxides of lead are reduced by the carbon present in the charcoal.

The charging of charcoal and raw material are repeated and the molten metal is collected in a pot at the downstream side of the furnace. The fuel used in the manufacturing process is charcoal and the quantity of charcoal used in one shift (8 hrs.) is approximately 30 Kg per furnace. The rotary furnace is manufactured from steel Plates with refractory lining inside the furnace to withstand temperature up to 1600°C. It is cylindrical in shape at the center and conical at both ends. The entire structure is supported by four numbers antifriction double row spherical bearings and shafts and bearings are firmly mounted on a common base frame.

The rotary furnace is driven by electrical Motor (which is 7.5 HP) and the Motor shaft is connected with rotary furnace shaft through a double reduction worm gear box, chain and sprockets. A low stage burner with high speed blower is fitted at one end of the Rotary Furnace to inject oil and for ignition. The other end of the Rotary Furnace is connected with a suitably designed chute to carry the dust particles to the pollution control equipment.

The fuel burner receives fuel continuously from a oil storage tank through insulated pipe line. A heater and pump is used to heat and pump the fuel during winter season to overcome the slow discharge rate due to viscosity of the fluid. Battery scrap, lead bearing members of the slag contains lead are charged inside the furnace manually and heated up to 800 to 900 °C after certain time the recharging process of scrap continues. The disintegrated tiny particles and dust along to the air Pollution Control System for filtration.

The rotary furnace is closed while processing the metal and the ambient air quality around the furnace is conforming to the latest norms prescribed by the Central Pollution Control Board. The Smelting process proposed in lead recycling unit is explained in detail below:

The raw materials, namely, the batteries are received at the unit. The battery casings are broken with the help of cutting machines and sorted accordingly.

The plastic containers, polypropylene wastes are processed in plastic grinding machines and the PVC separator waste is sold to the PVC recyclers.

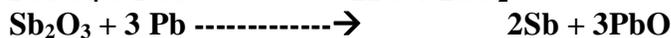
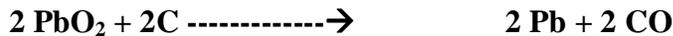
Initially, the lead scrap is fed into the rotary furnace and the flux agent like charcoal, iron borings are added for ignition.

The burner supplies the required heat for melting of scrap. After a sustained fire is established, the lead in the scrap (raw material) is melting gradually. The metallic lead in the scrap melts and the oxides of lead are reduced by carbon from charcoal.

The chemical reaction shown is below:



**The chemical reaction taking place during smelting process is as follows:**



**While heating up the battery plates, sulphur dioxide gas generated.**



The fuel used in the manufacturing process is furnace oil.

The lead obtained from rotary furnace and reverberatory furnace is stored in a separate place and it is known as impure lead. These leads are refined for making lead alloys and lead oxides depending upon customer's requirement.

The pot furnace is used for refining and alloying process. The alloy pot is connected to the air pollution control system for filtration. The dust particles obtained from the alloy pot burner are fed into a carbon arrestor and then passed to chimney which is 10 m high.

The disintegrated tiny particles and dust particles like SO<sub>2</sub>, NO<sub>x</sub> and lead particles are carried to the air pollution control system for filtration.

The following machinery will be employed for the processing.

- Rotary furnace

- Charcoal Furnace 1
- Charcoal Furnace 2
- Charcoal Furnace 3
- Charcoal Furnace 4
- Melting Pot 1
- Melting Pot 2
- Gravity Chamber
- Cyclone Chamber
- Bag House
- Gen Set
- ID Fan Flower
- Chimney
- Furnace Oil Tank
- Air Compressor
- EB Connection

## **7.9 Waste Plastic Recycling**

Plastics are an arbitrary group of artificial materials, generally of synthetic organic origin, which at some stage in manufacture are in plastic condition during which they are shaped, often with aid of heat and pressure.

### **Understanding the definition:**

Arbitrary Group: There is no code or specification with which a material must comply in order to be called a plastic. For example, synthetic rubber fulfills all the conditions laid down in the above-mentioned definition yet it is not included in the list of plastics.

Artificial materials: Material made by compounding, different from naturally occurring materials such as wood, sandstone or metals.

Generally of Synthetic organic origin: In organic compounds the principle element is carbon. Most of the plastics are made of simple organic chemicals raw materials. Certain naturally existing organics such as bitumen, casein or cellulose are also employed for the manufacture of plastics.

Plastics undergo permanent deformation under stress. During some stage of its manufacture they are truly plastic and capable of being shaped. At ordinary temperatures plastic items are not plastic but solid like.

Plastics are shaped by means of heat and pressure in a mould. Process is called moulding.

### **7.9.1 Waste Paper Recycling**

Waste Paper recycling is the process of converting waste into new paper products. The process of paper recycling involves mixing used paper with water and chemicals to break it down. It is then chopped up and heated, which breaks it down further into strands of cellulose,

a type of organic plant material; this resulting mixture is called pulp, or slurry. It is strained through screens, which remove any glue or plastic that may still be in the mixture then cleaned, de-inked, bleached, and mixed with water. Then it can be made into new paper. The same fibers can be recycled about seven times, but they get shorter every time and eventually are strained out.

To start the paper recycling process, the waste paper needs to be sorted, such as by newsprint, computer paper, magazine paper etc, as different types of paper are treated differently during the paper recycling process to make different types of recycled paper products. For example, finer paper with multi-colored ink would require additional processing. Effort is taken to ensure that the waste paper is free of any pins, clips, staples etc.

The major process involved in waste paper recycling is as follows

- Pulping
- Pulp screening and cleaning
- Deinking
- Refining, color stripping, bleaching
- Paper making

### 7.9.2 Process Description

**Pulping:** During this stage of the paper recycling process, the sorted paper is usually soaked in huge pulpers, which contain water and chemicals. The pulper shreds the paper up into smaller pieces. The heating of the paper mixture also breaks the paper down more quickly into the paper fibers. The paper mixtures turns into a mushy mix, known as a pulp.

**Pulp screening and cleaning:** The pulp is forced through screens with holes of various shapes and sizes to remove small contaminants such as bits of plastic and globs of glue. In addition, the pulp may also be spun around in large cone-shaped cylinders. Heavy contaminants (eg. staples) are thrown out of the cone via centripetal forces, while lighter contaminants collect in the center of the cone and are removed.

**Deinking:** The next stage in the paper recycling process involves deinking – removing the ink from the paper fibers of the waste paper. Sticky materials (referred to as “stickies”) like glue residue and adhesives are also removed at this stage. Deinking is achieved by a combination of mechanical action (eg. shredding) as well as chemical means (eg. additional of chemicals). Small particles of ink are rinsed from the pulp with water, while larger particles and “stickies” are removed with air bubbles in a process known as flotation.

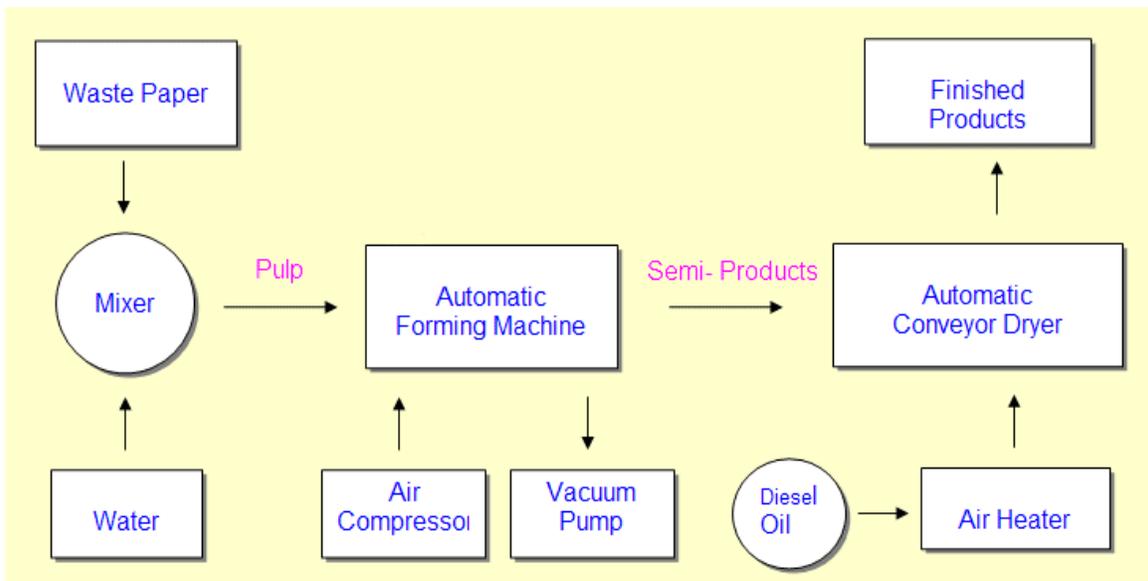
With flotation, the paper pulp is fed into a flotation cell, where air and soap-like chemicals called surfactants are injected into the pulp. The surfactants cause the ink and “stickies” to dislodge from the pulp and stick to the air bubbles as they float to the surface of the mixture. The inky air bubbles create froth which is then removed, leaving the clean pulp behind.

**Refining, color stripping, bleaching:** During refining, the pulp is beaten to make the recycled fibers swell, as well as to separate the individual fibers to facilitate paper making. If the recovered paper is colored (eg. color printed paper), color stripping chemicals are added to

remove the dyes from the paper. From this processing, brown paper is obtained. If white recycled paper is to be produced, the pulp would need to be bleached with hydrogen peroxide, chlorine dioxide, or oxygen to make it whiter and brighter.

**Paper Making:** In the last stage of the paper recycling process, the cleaned up pulp is ready to be made into recycled paper. The recycled fiber can be used alone, or blended with new wood fibers (ie. virgin fibers) to give it extra strength or smoothness. The pulp is mixed with water and chemicals, such that the pulp is 99.5% water. This watery pulp mixture then enters the head box of a paper making machine, and is sprayed in a continuous jet onto a huge wire mesh-like screen moving very quickly through the paper machine. On the screen, water starts to drain from the pulp, and the recycled fibers begin to bond together to form a watery sheet. The sheet then moves rapidly through a series of felt-covered press rollers which squeeze out more water from the pulp. Schematic diagram of paper recovery is shown below in **Figure 12** below.

**Figure 12**  
**Flow Chart of Wastepaper Recycling**



## **8.0 Renewable Energy**

Renewable energy is energy that comes from natural resources such as sunlight, wind, rain, tides, waves and geothermal heat. About 16% of global final energy consumption comes from renewable resources, with 10% of all energy from traditional biomass, mainly used for heating, and 3.4% from hydroelectricity. New renewable (small hydro, modern biomass, wind, solar, geothermal, and bio fuels) accounted for another 3% and are growing very rapidly. The share of renewable in electricity generation is around 19%, with 16% of electricity coming from hydroelectricity and 3% from new renewable. In the proposed project it is intend to set up 2 MW solar power project in the closed landfill after evaluating the recent developments in solar energy on closed landfill on following criteria.

Solar power system considerations with respect to landfill applications,

Landfill technical and engineering considerations, and Regulatory considerations.

At Ramky, we believe there are several important reasons for considering clean and renewable energy facilities on contaminated lands

Contaminated lands offer hundreds of acres of open space in areas where solar Installations may be less likely to involve community concerns over aesthetic impacts.

Contaminated lands may have lower overall transaction costs than Greenfield sites. Development of Brownfield's can assuage the stress placed on Greenfields to site clean and renewable energy facilities.

Contaminated lands may have environmental conditions that are not well suited for commercial or residential zoning or otherwise have low demand for real estate development. Electricity generated from renewable energy projects on contaminated or remediated lands can then be used onsite or credited for offsite use.

### **Solar Power System**

There are a fairly wide set of considerations we have considered when planning a solar system to be placed over a closed landfill. With respect to the solar technologies available, considerations includes concentrating solar power (CSP) or photovoltaic (PV) will be best suited to site specific conditions. Additional factors considered during the planning process, given the constraints of building on a landfill cap, are the desired output capacity, weight characteristics, and degree of mechanical stress expected from the panels weights and other onsite weather conditions.

### **Ground Mounted Solar System**

Installation of a solar energy syste

m on a landfill cap will require the use of ground mounted solar arrays. Ground mounted solar systems often involve aluminum or galvanized steel framing that is attached to a concrete foundation. The concrete foundation can also be referred to as a pier or footing and the panel supports can be referred to as stanchions.

With respect to footings, several designs are available.

Shallow poured concrete pillars, Pre-fabricated concrete, Slab, Ballast frames, Driven pile, Earth screw augers

Figure below the aluminum support stanchions supporting the PV panels are shown below  
PV Panels for Generating Solar Energy



### **Solar System Weight Considerations**

PV cell and support system weight characteristics have important implications for installation on landfill caps because of weight bearing limitations. There are three general types of PV panels with many different variations and weights associated with each type. The three general PV cell materials are monocrystalline, polycrystalline, and amorphous thin film. Monocrystalline panels offer the most efficient power production per unit area but can be costly and heavy. Both monocrystalline and polycrystalline cells are rigid and require mounting in a rigid frame to protect from cracking. Amorphous cells are the least efficient on a power output per unit area basis but can be lighter weight than both monocrystalline and polycrystalline cells and offer greater pliability as they are manufactured on flexible surfaces. For the Industrial Land fill weight many not be the key constraints. However in other landfills (municipal), where weight is an engineering concern, amorphous thin film PV cells could be the preferred choice.

New and emerging technologies like the Uni-Solar model PVL flexible laminate amorphous thin film cells can dramatically cut weight as they offer high output per unit weight and can be applied directly to landfill geomembrane caps, these newly developed flexible laminate PV strips eliminate the necessity for system mounting and foundational structures. Monocrystalline and polycrystalline panels can be lighter on a power output per pound basis than conventional thin film (amorphous) panels, where open space is limited and maximum electricity production is sought, polycrystalline or monocrystalline PV may be preferred because of the output advantage over thin film. However, with any PV cell type it is important to keep in mind the various shading considerations at landfill sites with limited space; optimal solar design requires strategic placement of arrays such that no shading occurs.

Single and double axis sun- tracking systems have not been considered in the system design as they will be heavier than fixed tilt axis mounting systems, thus requiring deeper piers and footings unless there are surface mounted footings. The deeper piers required by sun-tracking

mounting systems will increase the weight placed on the landfill and possibly increase settlement or jeopardize side slope stability at the site.

Options for foundations of solar system installations on landfill caps include concrete slabs, poured and pre-fabricated concrete footings, and ballasted platforms. Slab foundations have not been considered as they will be heavier than concrete footings or ballasted platforms and will therefore create a greater risk to landfill settlement and side slope stability. Ballasted platforms are a lighter weight option and can sufficiently anchor a solar system to a top deck, engineering difficulties with side slope installations is suitably addressed through the design. We have selected a solar power system whose cumulative weight is appropriate given the depth of the landfill cap, waste characterizations, and side slope measure. We have limited the load to maximum of 500 Kg / M<sup>2</sup> on a distributed basis. This load / design criteria is well within safe limits of the load capacity of the landfill liner cap and other necessary components.

### **Wind Loading:**

Wind loading increase the weight placed on solar components and can increase the stress applied to the support structures. We have complied with the International Electro technical Commission (IEC) standards 61215 and 61646 that establish the industry standards for crystalline cell and amorphous thin cell mechanical loading, respectively. Customary solar panels are typically certified to withstand a maximum mechanical loading of approximately 250 Kg per square meter, which converts to a wind speed of approximately 170 Km per hour. The solar panels and mounting systems are thus certified for higher mechanical loading. In addition we have suitably planned for routine operations and maintenance of the landfill which entails mowing of surface vegetation on the cap.

### **Photovoltaic Power Generation :**

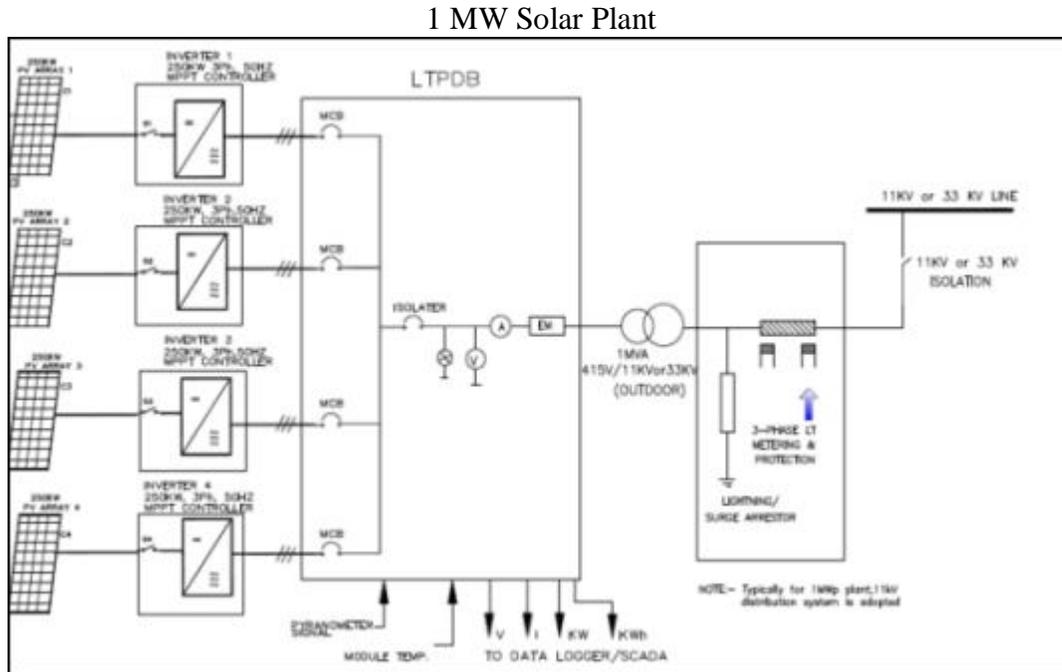
The overall system would comprise of following equipments  
Solar array employing Wp or higher rating PV modules  
Support structure made of galvanized steel angles with SS304  
IP65 rated field junction box made of FRP/ Poly carbonate material.

Multi-stranded, UV protected, PVC insulated, PVC sheathed copper cable. The cables are sized to minimize the voltage drops & the power loss. The cables confirm to IS1554/ IS 694. Snap on connectors are employed for interconnections.

Power Conditioning Unit (PCU) receives DC power from DCDB (Where SPV array is terminated). PCU has built in software based Maximum Power Point Tacking (MPPT) to harness maximum power from the solar array. Typically the solar array will operate at 650 to 750 V DC under the maximum power point operation. The DC power is then inverted to utility quality three phase power & this power shall be exported to utility. Necessary grid synchronizer is incorporated in the PCU through unique software.

Data acquisition system & Bi-directional energy metering is also built in to the system. An integrated unit (Import –export meter) for energy generated by the plant is also provided. An integrated SCADA system monitors the PCU & HV substation parameters. Certain operational controls are provided in the SCADA (Supervisory Control &Data Acquisition). In order to enable export of power to HT line (11KV/ 132 KV) LT power generated from the PCU is taken through a Star –Delta HV transformer.

**Schematic diagram of 1MW solar plant is shown below in Figure below.**



**Description:** The photo voltaic array is divided in to four quadrants of each 250KWp minimum. Each string in the array shall have its own string monitoring unit which shall be one of the major diagnostic tools for the system operator. Each unit array has field connected separate solar radiation meter& SPV module temperature sensor. The respective digital outputs are taken to a supervisory controller located in the control room. The Inverter unit employs state of the art DSP based technology to have conversion efficiency over 95%. Electronic surge arrestors are provided at the DC input & the AC output of each inverter. Necessary HT switch gears such as 33KV VCBs are provided for HT isolation & protection.

Each 250KWp system will have an independent Data Acquisition System (DAS) which would produce the real time Data as well as event logs indicating all the supervisory faults also. Data logger of each 250KWp unit shall be integrated in to a mini Web server for the purpose of integrating the Data. These Data via Profibus is taken to a master Supervisory Control & Data Acquisition (SCADA system).Service interface on the operator panel is also provided.

## **Weather Monitoring Station**

As a practice, a mini Solar Weather Monitoring station is proposed to be installed to monitor the weather parameters in Real Time and store the monitored data to the SCADA or a separate computer. The actual KWH annual energy generation then can be corroborated with the stored weather data gathered (Rainy Days inclusive) in real time. The Pyranometers offered are calibrated and traceable to ISO standard & Global Radiation norms. The Transducers, data acquisition systems accuracies are standard based as per WMO (World Meteorological Organization`s Norms. The sensors and data acquisition outdoor unit with dedicated power supplies with battery backup for unmanned operation, communication cable to the indoor SCADA Computer, software, and calibrating tools shall be in the scope of supply. The data stored in this computer may be collected either by a USB stick or arranged to be transmitted by RAMKY to its O&M Team as necessary

The following Parameters are proposed to be logged and stored in Real Time Basis with Time, date, day, year stamp /tagging.

Temperature, Principle :NTC , (Range :0-60deg C, Accuracy: 0.2 deg C )

Air Pressure, Principle: MEMS Capacitive ,(Range: 300 to 1200HPa, Accuracy: 1.5hPa)

Wind Direction, Principle: Ultrasonic,(Range: 0-60M/Sec, Accuracy: 3degree)

Wind Speed, Principle: Ultrasonic,(Range:0-60M/Sec,Accuracy:0.3M/Sec)

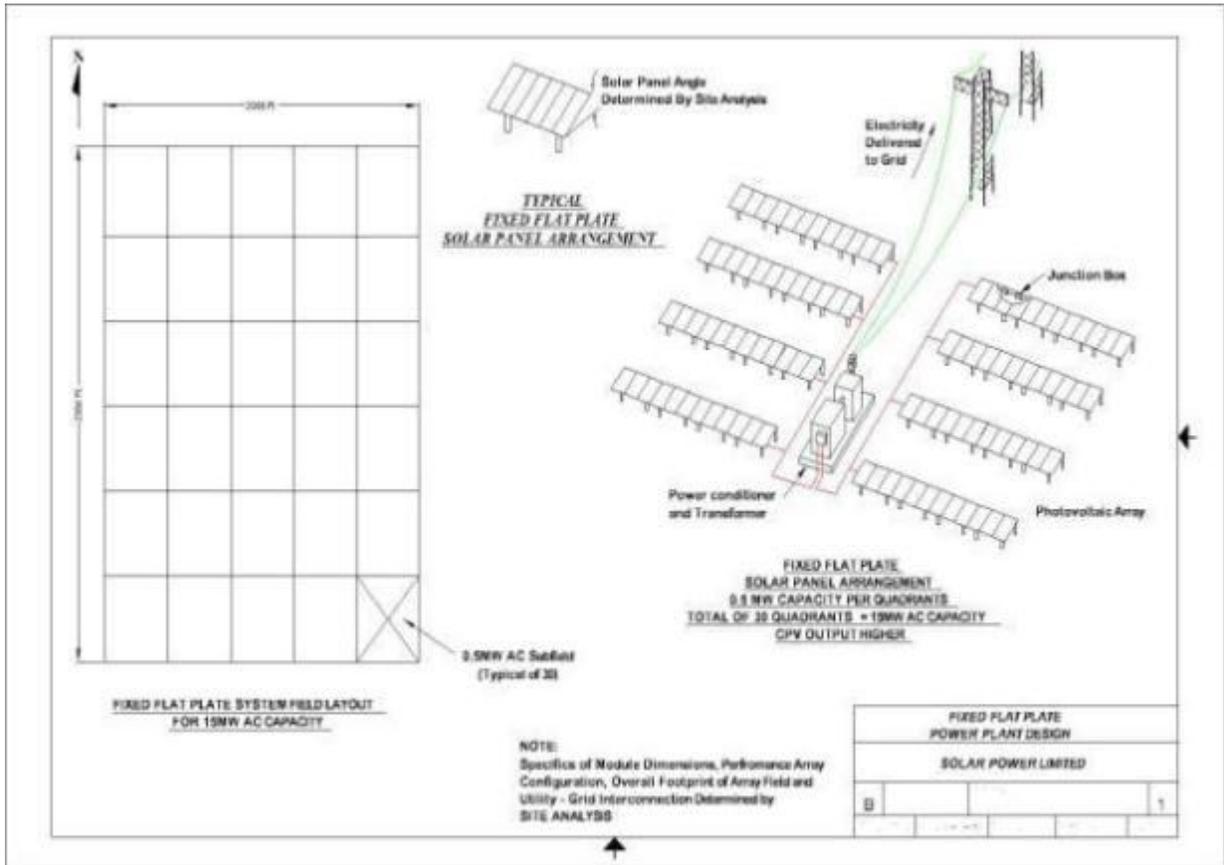
Pyranometers (Irradiance: W/Sq. M measurement), Standard: ISO, Class-2, To suit Maximum Irradiance: 2000Watts/Sq M, Max Operating Temp: 80 deg C, Non stability<1%, Spectral Range (50% Points):310 to 2800 nano meter.

Particulate meter: Principle: Pulse free Diaphragm pump, 0-6LPM flow rate, dust sampler. Measuring Range: Total suspended particulates data of site needs to be furnished to confirm details. Accuracy: Nominal 10 micron cut off point at 5 LPM typical sampling rate.

## **Plant Layout**

Plant layout of typical PV technology is shown below in Figure below.

## Layout of PV Technology



## Components of Solar Plant

### Brief Description of the Solar Plant

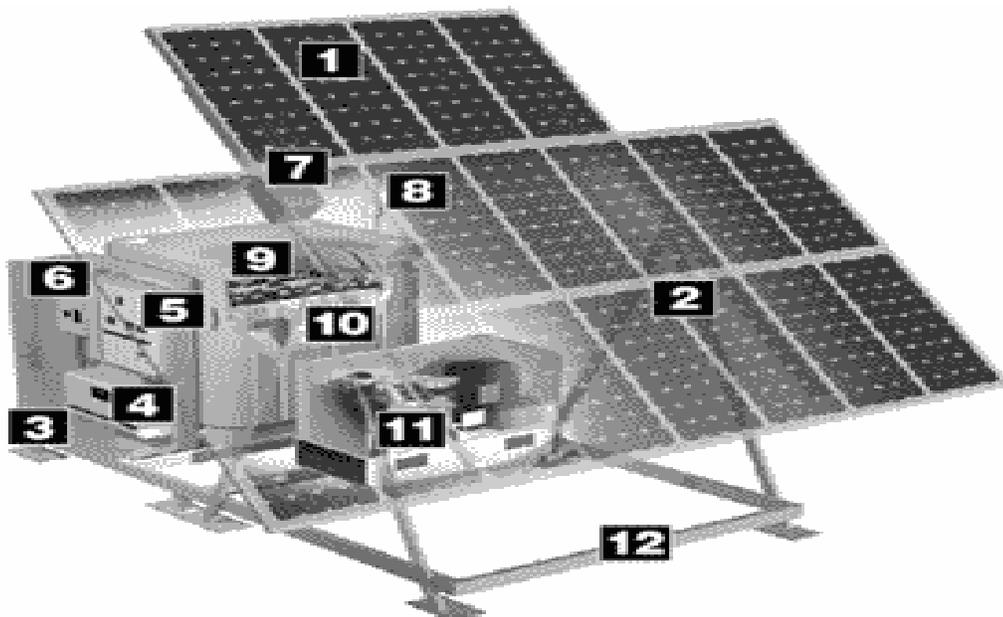


Photo Voltaic Panels, (PV) High-efficiency, single crystal silicon PV modules provide higher amp-hour per watt output than other technologies and include dual bypass diode protection. Modular PV panels permit expansion to accommodate increased loads.

Adjustable Array Structure, PV array tilt is easily adjustable from 30-60 degrees to maximize solar energy. Further adjustment of 0-30 degrees possible with special positioning bars.

Control Centre, The control enclosure is a powder-coated steel box housing the power distribution components (DC controller/distribution, inverter and AC distribution), disconnects, system monitor and appropriate wire terminals. Enclosure is provided with rainproof vents and a ground fault protected electrical outlet. Optional remote monitoring equipment is available.

Inverter/Battery Charger, Microprocessor-controlled, high-efficiency sine wave inverter with three-stage, temperature-compensated battery charger. Peak conversion efficiency of 96%, protection circuitry, LCD display with user and setup menus.

DC Controller, Solid state, low frequency, pulse-width modulated solar charge control with battery temperature compensation and automatic night time disconnect.

AC Distribution Panel, Output AC breaker panel provides surge protection and flexibility for multiple AC load requirements.

DC Combiner Box, Provides PV circuit disconnects and lightning/surge protection for electronic equipment.

Ventilator Fan, Designed for active ventilation of hybrid battery enclosure to prevent accumulation of hydrogen gas.

Batteries, Available in three battery types: economy flooded lead-acid, industrial flooded lead-acid and sealed lead-acid. Flooded lead-acid battery comes with recombiner caps to minimize water loss. Sealed battery available for maintenance-free performance. The control system maintains the batteries between 20% and 100% state of charge.

Battery Enclosure, Sealed batteries are housed in a powder-coated steel, lockable enclosure with filtered vents. Flooded batteries are housed in an insulated, vented thermoplastic unit with lockable lid and drain plug. Designed to minimize battery temperature extremes, eliminate battery bank hot spots, prevent freezing and extend useful battery life.

Generator Hybrid, Commercial and Industrial engine generators available to meet requirements. Includes battery, alternator, remote start/stop contacts, self-contained protection and automatic safety shutdowns. Package includes weatherproof housing, vibration isolators on steel skid, flexible couplings, and replaceable dry element air filter. Propane and diesel fuel types available.

Structure, Industrial grade heavy-gauge steel coated with a durable hot-dip galvanized finish. Available in four configurations: ground mount, road trailer, off-road trailer and breakdown kit.

### **Operation and Maintenance Practices:**

When mounting the module on the structure, keep the displacement of the forth corner of the module smaller than 2mm for 1000mm of the diagonal of the module after other three corners are placed on the structure.

- Be careful in handling polarity of the insulated output wires.
- This module must be grounded by minus pole, install modules and ground mounting structure in accordance with applicable law of each country.
- Consult the government before the installation of the modules in case if installation is required by the law.
- The modules shall be installed and maintained by qualified personnel.
- Follow safety precautions of the battery manufacture if batteries are used with the modules.
- Consult the manufacturer for the proper installation on special vehicles such as boats and campers.
- The modules must be mounted using clips on the long sides of the module according to the installation manual.
- Remove the cable securing tapes and cable holders carefully before the installation.
- The module is fitted with SMK corporation connectors which are mechanically and electrically compatible with multi contact PV-KST/KBT4 as of 19th Nov 2010.
- The connections must be completely done and locked.
- Do not shade portion of the PV module surface from the sunlight for a long time. A hot spot phenomenon which is appeared as white dot may occur on the shaded cell.

### **Operation:**

When a part of the module is shadowed, the hot spot may be caused, therefore do not shadow the cell.

The module shall be maintained by qualified person.

The electrical characteristic degrades when the front cover of the module becomes dirty.

Do not pour solvent when cleaning the modules.

Do not produce sparks near flammable vapors.

Do not expose the modules to sunlight concentrated with mirrors, lenses or similar means.

Keep modules away from children.

Installation of solar energy systems on landfill side slopes and caps is though complicated by a variety of engineering obstacles, various solutions have come up to mitigate these. Following general guidance have been considered to overcome engineering obstacles of landfill reuse as they apply to solar system installations.

## **Settlement**

A special consideration is taken while designing the solar installation on the landfill cap is the settlement. The collective uniform and non uniform landform deformations caused by physiochemical, biochemical and mechanical process that change the properties of the buried waste over the period of time. Total settlement is described as an overall subsidence across the landfill. Differential settlement is described as localized subsidence that results from heterogeneities across waste debris in the landfill. Specifically, settlement can occur in landfills through any of five processes,

1. Mechanical consolidation – (Negligible – daily consolidation will be done)
2. Biochemical degradation – (Negligible)
3. Physiochemical change.
4. Migration of fine refuse into the voids of large waste materials (raveling) – (Considered and mitigated through the structural designs)
5. The absolute degree of active settlement depends on the depth of the waste heap, the type of waste present, the method of placement, and age of the landfill.

Settlement due to above reasons has been considered in the overall design parameters to address the issues related to long-term post closure care of the landfill and the system components of a solar energy farm.

For developments on landfills, there are numerous methods to mitigate settlement. Geo grid reinforcement can be used to strengthen the cover soils above the geo membrane. Beyond structural reinforcement, designed flexibility in the solar system can preclude damages to the solar configuration caused by settlement. The use of shims and adjustable racking systems in solar mounting structures can allow for amending the solar system in ways that conform to landscape morphology.

Being selective in where solar energy systems are placed on a landfill can minimize settlement impacts. One of the strategies used is to place the solar facility on the oldest section of the landfill top deck, since the rates of settlement generally decrease over time. In addition the nature of different buried materials; for example, a solar system placed above old construction debris that has been previously compacted will not experience significant settlement because of low biochemical degradation.

## **Cover Material Integrity**

For the most part, either a flat or north-to-south trending slope is optimal for solar energy production. Clearing and grading activities are carried out in a manner that will not damage the landfill cap nor expose any of the underlying waste debris, particularly when conducted in thinly capped areas.

During the planning process, adequate measures will be taken to ascertain the depth of the landfill cover and the anticipated deadweight loading of the entire solar energy system. We would maximize the level surfaces for adequate system stability, which may necessitate

moving soil from deeper areas to shallower areas or bringing additional top soil to the site. In almost all cases, we may also use prefabricated concrete piers or concrete slabs will be adequate to support a solar system.

All the necessary requirements for utility trenching have been taken care and typically, a minimum of 24 inches of soil is desired to trench for electrical line placement without any impact on a clay or geo synthetic liner.

### **Side Slope Stability**

Landfills will be assessed for side slope stability prior to construction to ensure that the cap and slopes can be developed without giving way. Slope instability will generally decrease over time as waste decomposition rates slow. Engineered retaining walls and vegetative surfaces can provide protection from erosion and the development of unsafe conditions.

Building on side slopes much larger than 5 degrees is complicated by shadow effects and the need for increased erosion and storm water control systems. Moreover, increased operations and maintenance costs may accrue over time for repairs to the side slope. For higher degreed slopes, regarding and importation of additional top soil may be necessary to achieve a slope that is favorable to supporting a solar system.

South facing landfill slopes are ideally situated to maximize solar exposure in higher latitudes once shading is accounted for. We have considered a balance between optimizing energy production and ensuring technically sound solar array placement. Side slopes will require strong foundational systems like poured or pre-cast concrete footings to oppose the pressures of dynamic loading. As a general rule, higher degreed side slopes warrant lighter solar arrays and strong foundational materials have to be considered for designing.

### **Proposed System:**

The proposed power project envisages a power plant of 2 MW (AC). The power project will be based on crystalline technology equipped with axis trackers. The DC output of the power modules will be converted to AC output with the help of solar inverters. The voltage will be stepped up with the help of transformers. Both on C side and AC side of conversion, and at the grid interconnection protection and safety devices will be provided to enable safe and reliable operation of the complete solar power system. Monitoring, metering and analysis of system provided with the power plant will help to record, store and transfer data which is essential for the plant. The power evacuation will be done at 66 KV.

### **System Components:**

- Solar modules
- Inverter
- Transformers
- Solar trackers
- Junction boxes
- Protective relays

- DC distribution board

SCADA system, an integrated SCADA system capable of communicating with the inverters and provide information of the entire solar PV panel. This SCADA will provide information on the instantaneous output energy and cumulative energy for each inverters

Electrical system, The DC output from the PV modules is converted to three phase AC by means of inverters. The inverter output are fed into an AC distribution board which in turn will be connected to LV panel in the control room. The power evacuation system comprises of Transformer ( oil immersed type), Low Voltage panel, High voltage panel, metering panel, KLT and HT cable, Control and power evacuation cables

### **9.0 Waste to Energy Plastic to Fuel**

The Technology of converting waste plastic into fuel is in various stage of development. Pilot plants have been set up and efforts are on for a Techno-commercial feasible and sustainable commercial plant. REEL will look into establishing the option of recycling facility in future. A brief write-up of the process is given in **Figure 13** below:

Waste Plastic can be converted into fuel by the Pyrolysis Technology. The process extracts Fuel from Waste Plastics. Pyrolysis is a process of thermal degradation in absence of Oxygen. Plastic waste will be treated in a cylindrical chamber at temperatures of 370°C – 420°C. Catalyst are added in the reactor to crack the Polymer and convert the waste into Gas. This Gas is further passed into condenser where most of them condense into Fuel. The non-condensed gas is utilized for heating process.

- Pre Drying of the waste plastic material to eliminate moisture
- Indirect Heating with gradual increase of temperature.
- Addition of Catalysts for converting the waste material into gas
- Condensation and fractionation of the Pyrolysis vapors to produce fuel.
- Input Material which can be converted into Fuel by the Pyrolysis process:

**Figure 13 Pyrolysis Process**

